American Engineer

JULY, 1947

VOLUME 17 NUMBER 7

NATIONAL SOCIETY OF PROFESSIONAL ENGINEERS

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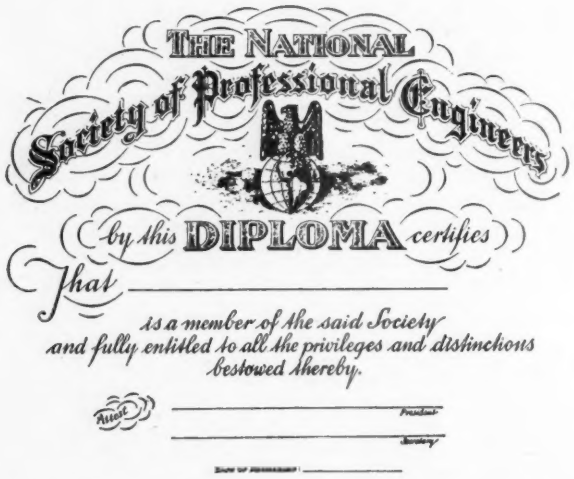
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THE AMERICAN ENGINEER

Published monthly in the interests of the Engineering Profession

VOLUME 17, NUMBER 7 — JULY, 1947

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All editorial material and correspondence relating to subscriptions or Society membership should be addressed to 1359 Connecticut Ave., N. W., Washington 6, D. C. Send change of address on form 3578.

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Subscription Rates

$1.00 per year in advance to members of the National Society of Professional Engineering and its Affiliated Societies. $2.00 per year in advance to non-members in U.S.A. and its possessions, Canada and Mexico. Foreign, $4.00 per year. Single copy 25c.

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Entered as Second Class Matter March 11, 1942, at the Post Office, New York, under the act of March 3, 1879—application pending for transfer to Baltimore, Md.

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EDITORIAL

"Stop Puttering Around"

Eugene W. O'Brien, national president of the American Society of Mechanical Engineers, in a recent luncheon address before his organization cited responses to a progress report on the activities of EJC which was sent to the membership of ASME. Some 500 members of ASME sent back comments as a result of having received this report. In general, according to Mr. O'Brien, these "were favorable to the accomplishments attained" by EJC, "the projects under way, and the objectives of the entire program."

Most Common Comment

The most common comment, according to Mr. O'Brien, (and this is in accord with NSPE experience) reflects the long standing need for concerted action in the profession, of unification of engineers and engineering societies. In support of this statement he cited, among others, the following quotations:

By a research design engineer, Indiana: "One necessary thing for engineers is a single national society of all engineers, in addition to overall societies covering single fields such as ASME."

By a junior executive, consulting, Washington: "Am pleased with the progress made by EJC. However, I believe that all founder societies will have to support, or make themselves into some form of central organization that will promote engineering as a profession."

By a junior engineer, Massachusetts: "Am interested in some type of federation of engineering societies, to strengthen common causes, but with retention of present specialized groups."

These and other pertinent statements cited by Mr. O'Brien seem to indicate that the debate as to whether there is need for a centralized engineering organization is over. The only question now is: "What type of organization should it be?"

How is NSPE regarded? For an answer let us review some of the comments, in addition to the ones cited above, which refer specifically to NSPE.

By a Massachusetts Process Engineer:

"Stop puttering around and support the NSPE. What the EJC has not done and will not do is what should give us concern. The long involved shuffling of ECPD is a sample of too little and too late. Let's have action."

By an insurance engineer in the West: "Why not work with National Society of Professional Engineers—stress importance of registration?"

By an institutional engineer, New England: "Against doing work in the fields of collective bargaining and economic status which had better be left to the NSPE. Let's stick to arts and sciences of mechanical engineering."

We believe that a fair conclusion is that NSPE is highly regarded by some members of ASME. There are some members of the Mechanical Society who believe that NSPE is the answer—that it represents the central unified organization of engineers which is needed to deal with the social, economic and ethical aspects of the profession just as the Founder Societies represent the organizations needed to deal with the technical problems.

One Answer to Problem

We hope that this feeling will grow throughout ASME and throughout all other engineering groups. NSPE's program is aimed to make this condition a reality.

Since there is general agreement that there is need for an organization of engineers to deal with professional problems and since NSPE has much support in the founder societies, it seems to us that every member of the profession should examine the problem of professional representation carefully.

We believe that one, and only one, conclusion can result from such an examination. It is:

"The time has come to 'stop puttering around and support NSPE.'"

The Editor

Reclamation Program
AN ENGINEERING JOB

The Interior Department's reclamation program employs a large number of engineers directly and creates work which indirectly results in many more engineering jobs throughout the United States. Current program will cost about $100,000,000 —but this is less than nomal, according to Michael W, Straus, Commissioner of the Bureau of Reclamation. A normal program—if Congress appropriates the money—will cost between $200,000,000 and $300,000,000 — and employ many more engineers. While neither THE AMERICAN ENGINEER *nor NSPE necessarily agrees with Mr. Straus' point of view, this article is important as an official statement.*

By MICHAEL W. STRAUS
Commissioner
Bureau of Reclamation

ONE of the largest engineering jobs in the world today is based upon plans of the Department of the Interior for the conservation and orderly development of the natural resources of Western United States.

The Bureau of Reclamation is the principal engineering agency within the Department. A normal construction program for the Bureau might run anywhere between $200,000,000 to $300,000,000 a year, if funds were available for a continuing, steady and reasonable water development program for the West. In years of economic recession this program might be increased considerably.

2346 Engineers

Under the present construction program, which runs in the neighborhood of $100,000,000 a year, a recent count of men with civil service engineering classifications within the Bureau of Reclamation revealed 736 general (civil service title) engineers, 679 civil engineers, 286 electrical engineers, 262 mechanical engineers and 7 chemical engineers. Other engineering employees number 376 in various other classifications for a total of 2,346 employees with civil service engineering titles.

Under the supervision of the Bureau of Reclamation, and in coordination with other agencies of the Department of the Interior, such as the Bureau of Mines, Office of Land Management, Fish and Wildlife Service and Geological Survey, reports are being made to the Congress on plans for the coordinated development of all of the great river basins of the West. The Congress already has approved a plan for the development of the Missouri River Basin, and plans for Columbia River Basin, Colorado River Basin and Central Valley of California, all before the officials of the various interested states, preparatory to submission of these plans to Congress.

Greater Undertakings

Thus, the Department of the Interior, while already engaged in the construction of great multiple-purpose projects, is on the threshold, I believe, of still greater undertakings.

Inherent within the interest of every engineer is the capturing of a natural resource to give it the utility of time, place, and form. In the Bureau of Reclamation, engineers are occupied chiefly with the utilization of two great resources—land and water. In the 17 western states, where the Bureau operates, thousands of acres of fertile land have remained undeveloped because the rainfall is insufficient for the production of many types of crops. The water for the land is in the rivers and streams. Harnessed by dams, these sources constitute new wealth. Left uncontrolled, many western rivers are not only a wasted resource, but in time of flood, ravage the land and become a menace to life and property.

The beneficial use of the western waters extends beyond the function of irrigation which transforms desert land into productive farms. The production of low-cost hydroelectric power is an important partner of irrigation. Improvement of navigation, municipal water supply, fish and wildlife conservation, and other benefits, are practicable achievements.

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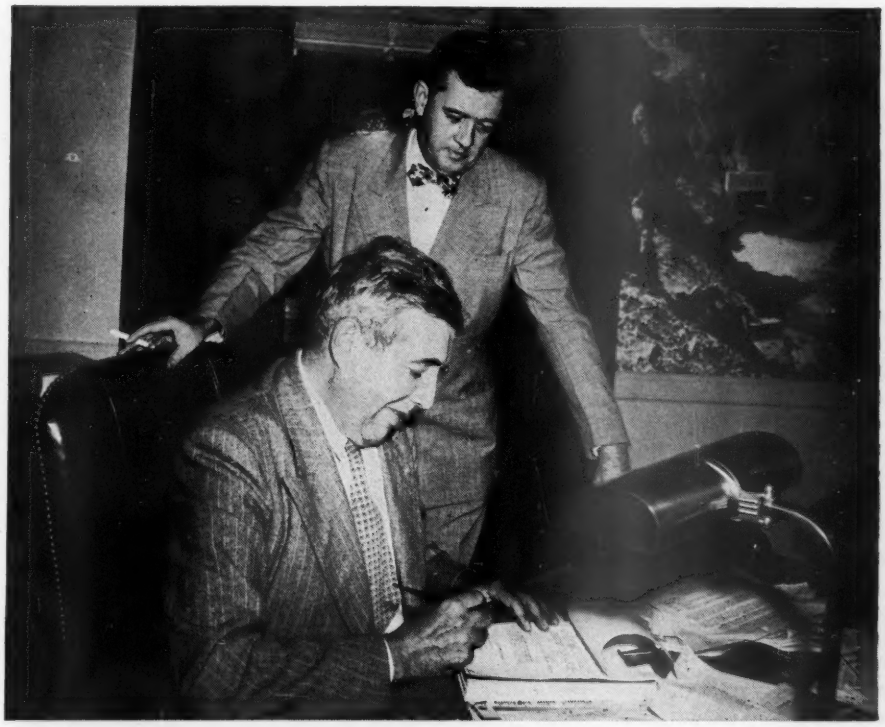

Michael W. Straus, the author, signs an important reclamation project construction contract as aide looks on. Photograph of reclamation dam may be seen in background.

Shasta Dam in California.

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To accomplish full utilization, the concept of a multiple-purpose project has been adopted as a basic part of reclamation engineering. In the past, much of the planning was directed toward the design of a dam which would serve a single purpose, such as irrigation alone or simply power production. The multiple-purpose project is designed and operated to perform as many functions as possible. The engineering structures may consist of a single dam or a series of dams, together with other works. The broader scope of the multiple-purpose project has required more thorough planning and a wider application of engineering knowledge.

The Engineer's Response

The engineer has recognized and responded to the need for reclamation dams, power plants, pumping plants, and canals, of greatly increased size and capacity, so that the greater tasks could be successfully carried out. The simplest projects having the most favorable conditions of construction were largely accomplished by the pioneer, who built a small, earth-filled diversion dam with a short irrigation ditch carrying water to nearby land. Many of the remaining projects involve the supply of water to a fertile plateau far above the river source or to distant land across a mountain range. The development of such projects requires immense storage dams, huge pumping plants, long tunnels, and river-size canals for successful accomplishment. Better use of construction materials, improved methods, and a higher degree of engineering skills are in continued demand.

Limited Resources

The many-faceted problem of modern reclamation is complicated further by the fact that the engineer has found himself dealing with a resource, which although regenerative in nature, is limited in available amount. Also, progress is most definitely controlled by legal, Congressional, financial, and economic restrictions which specifically restrict the engineers' direct approach to solving the physical problems inherent in reclamation. At full development, the rivers do not contain sufficient water to provide irrigation for all of the suitable land, and although generations will pass before all of the water in the rivers is controlled and used, present planning and designing assure that current reclamation works are part of an overall development which will provide for the maximum conservation and usefulness of the water at the end of development. To gain the desired goal, the Bureau of Reclamation initiated a program of long-range planning which envisioned the unified development of entire river basins. Detailed investigations of such great basins as the Colorado, Missouri, Columbia, Rio Grande, and Central Valley of California, were undertaken, so that as individual projects were constructed, they would fit into the comprehensive plan. Fortunately, much of this planning has been completed and incorporated in formal reports for direction and

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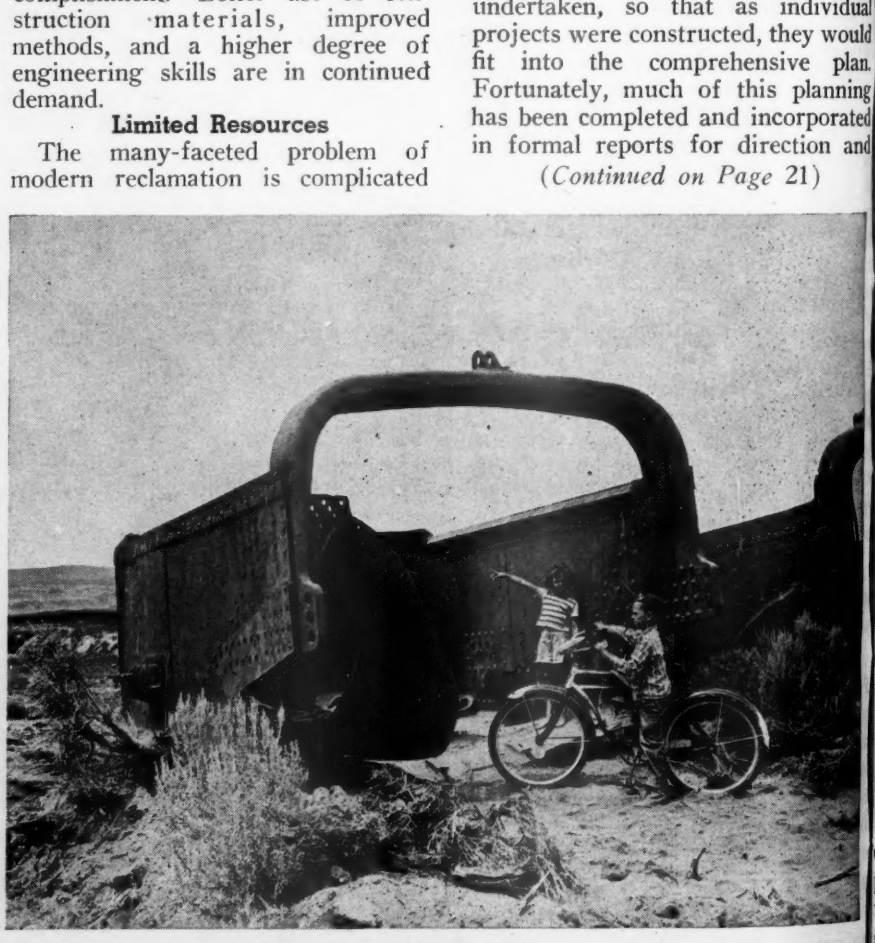

Reclamation project construction equipment is big. This is an immense bucket for a walking dragline used on the Columbia Basin Irrigation Project. It can handle 15 cubic yards of rock (31 tons) in a single scoop.

Engineering

THE TRAIN OF TOMORROW

The bright new world which was promised during the war has not materialized—as yet. For one reason or another, marketing of new products has been a slow process. Among the first new things to appear in concrete form is the Train of Tomorrow which represents an important engineering job. It also holds to promise of expanded engineering opportunities for the future. The staff of THE AMERICAN ENGINEER *has prepared the following summary of some of the engineering problems which were encountered in building the train. They will give an idea of what the future problems may be.*

Railroad passenger car builders will require more engineering services and will employ more professional engineers during the next decade than they did during the ten years preceding World War II.

This prediction is based on the actual experience of General Motors and the Pullman-Standard Car Manufacturing Company in engineering and building the Train of Tomorrow —the first concrete evidence of that bright new world which was promised during the war.

New In Design

The Train of Tomorrow is completely new in design. It represents an engineering job from the tracks up. While it is a big step in the direction of adequate rail passenger transportation for the future, it is only a pattern which can be followed by car builders. It is merely a start in the direction of luxury rail travel. Already, there are indications that purchasers of such plush equipment will want added innovations that will increase the demands for professional engineers.

It is impossible to predict what these innovations will be. However, it is possible to get an idea of what the future trend will be by examining some of the engineering problems that were faced and solved in building the new train.

The first big problems to be solved resulted from the original conception of what the car of tomorrow should be. In the summer of 1944, C. R. Osborn, Vice-President of General Motors and head of its Electro-Motive Division which designs and manufactures diesel locomotives was traveling through the Colorado Rockies in the cab of a locomotive. The magnificent view of the mountains rolled before his eyes and he realized that passengers never enjoyed such an unimpeded view of the scenery.

Thus was born the idea of the astra dome or glass enclosed compartment at the top of the car. Eventually, General Motors Engineers were asked to pass upon the practicability of the dome idea. They were fully competent because of their experience in building locomotive cabs.

The immediate questions to be settled were:

1. With the use of steel ribs and the heavy, bullet-proof glass developed during the war, could a dome be built that would provide necessary passenger safety?

2. Would it be low enough to clear most tunnels, bridges and station roofs in the United States?

3. Could the regular floor of the car be depressed sufficiently to provide headroom beneath the dome, as well as in the dome, and still meet clearance requirements of the railroads?

4. If the regular floor line were thus altered, could the buff and drag of moving cars be transmitted through a re-designed underframe instead of through the conventional heavy center sill?

In due time, each of these questions was answered yes. It was decided that General Motors should go ahead with the project and then, engineering skills were put to a severe test.

Among the classes of problems which were faced and solved are the following:

1. Improvement of lighting, air conditioning and refrigeration: In studying existing passenger cars, experts working on the Train of Tomorrow noted that lights were connected with the movement of the train and that starting and stopping caused them to dim and flicker. Old style air conditioning, was run by fans connected with wheels of train blowing over cakes of ice. Efficiency of refrigeration equipment was reduced because of its dependence upon motion of train.

The problems were all related to the power supply for their operation. The answer was found in the development of an individual power package or plant for each car.

Modern railroad usage of electricity has vastly multiplied former power requirements. To-

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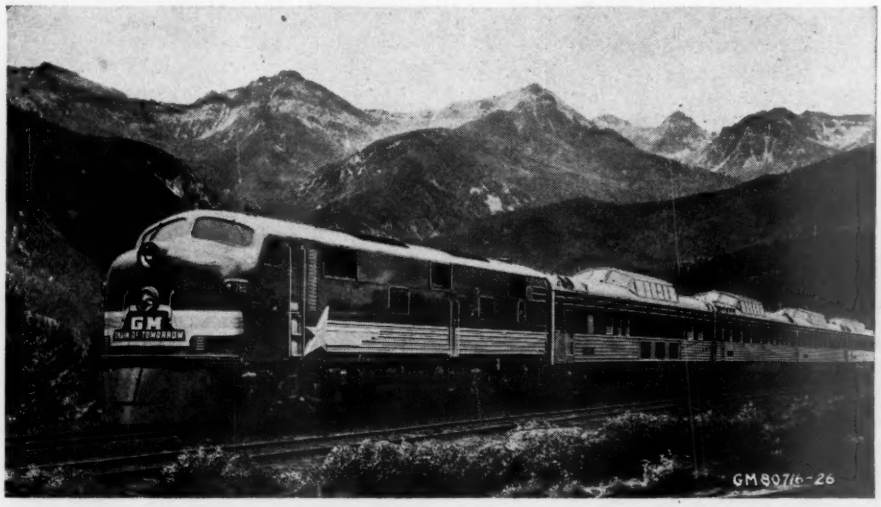

Train of Tomorrow in the Rocky Mountains where it was conceived.

The Astra Dome, distinctive feature of the train, posed a problem of glass installation, and taxed ingenuity of air conditioning experts.

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day, on a single car, facilities may call for enough generating capacity to light 100 average American homes.

The power package, which presented many engineering problems, is an independent diesel engine, with its own generator, mounted underneath each car. Thus, each car is self-sufficient as far as electrical power is concerned. It may be uncoupled from the train without interference with lighting, heating, cooling, ventilating, refrigeration, use of radios, electrical outlets for hand appliances such as razors, hair curlers, and so on. As a safeguard against breakdown of any unit, connections are furnished for tapping into the circuit of an adjoining car.

Here is a brief tabulation of the new Power Package's advantages over axle-driven systems:

a. Reduction of load on locomotive, saving as much as 600 horsepower on a 12-car train, permitting longer trains and rapid acceleration for faster schedules;

b. Saves 3500 pounds or more in batteries per car;

c. Full and constant electrical capacity regardless of whether car is rolling or in storage;

d. Permits use of highly reliable and efficient A.C. motors with minimum maintenance;

e. Permits use of standard A.C. devices, particularly important in dining and lounge cars where most common appliances are used;

f. Permits use of cool, efficient fluorescent lighting in harmony with modern design of cars, without auxiliary converting or voltage regulating equipment;

g. The 2-cycle Diesel engine, improved and tested under war conditions, provides highest reliability with minimum maintenance;

h. Maintenance facilities and personnel for Diesel locomotives can be used on these power units;

i. The same, non-hazardous, readily available, low cost fuel used in the Diesel locomotive is used in the unit, and exhaust fumes are non-toxic.

j. Simple removability of unit.

Air Conditioning

Air conditioning presented a peculiarly difficult problem because of the astra dome. Its glass construction made it extremely difficult to cool because of the easy accessibility of the sun's rays and its location at the top of the car.

A 10-ton-cooling system is installed in each car, complete with conditioner, ducts, compressor and condenser units. It produces a cooling effect equal to the melting of 10 tons of ice per day, six-tenths of it applied to the lower portions of the car and the remainder to the Astra Domes, which, while relatively small require proportionately greater cooling power.

All units of the system are engineered for matched operation and highest efficiency, but particularly important in this respect are the flood-type condensers which boost efficiency enough to produce the extra cooling required for the Domes without use of additional electric power.

The Conditioner cools or heats air and circulates it. Cooling is accomplished by evaporation of Freon, an odorless, non-toxic refrigerant. Heat-

Mobile telephone installations represent problem in electrical engineering.

ing is supplied by a steam coil within the unit over which air is driven.

Ducts ingeniously built into the varying structures of the cars convey the conditioned air to all parts of each car and deliver it, without drafts. Controls are automatic, regulating temperature and humidity as desired, in all seasons, in all climates.

Refrigeration

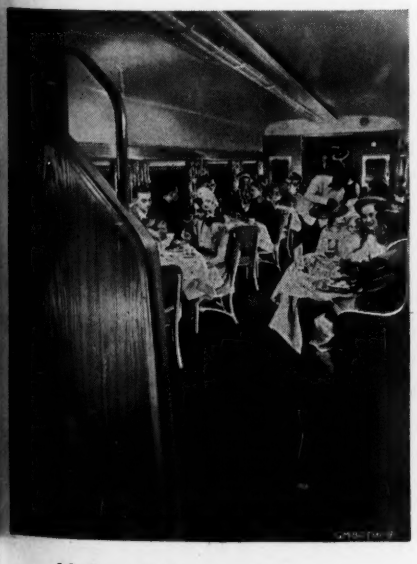
Providing modern, spacious refrigerator fixtures throughout the train to operate automatically and keep beverages fresh, nutritious and appetizing presented another engineering problem.

The temperature range of these cold cabinets and fixtures varies with their purposes, ranging from 50 degrees F. for drinking water to zero F. for frozen foods. Cool, fresh water is constantly circulated throughout the train.

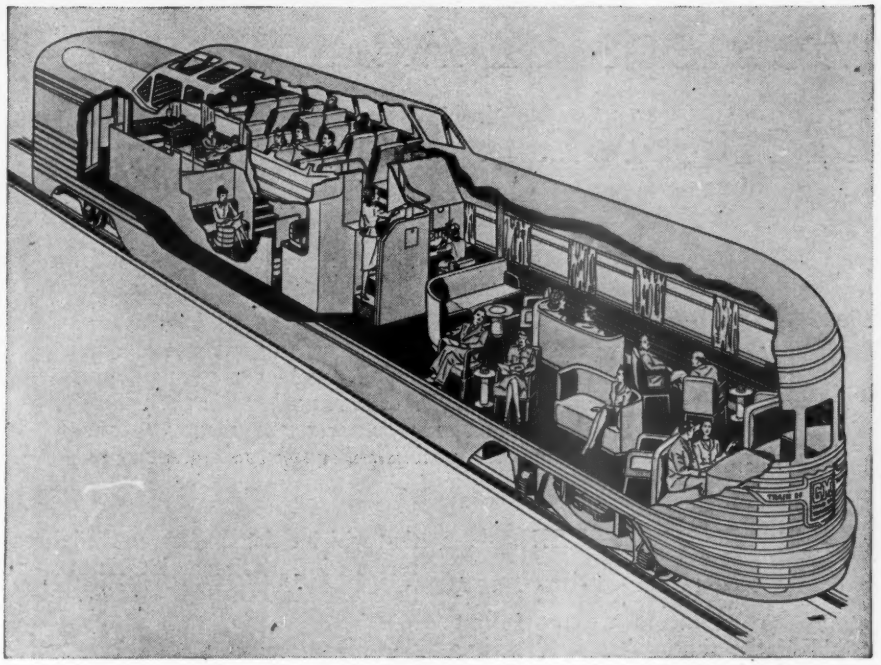
Dining Car Refrigeration

Kitchen, pantry and Astra Dome of the dining car offer the finest in modern food refrigeration on wheels. Eleven separate refrigerated fixtures provide 111 cubic feet of storage space for fresh and frozen foods—more than would be provided by 15 standard-size household refrigerators. Four compact condensing units, concealed in different locations in the car, supply dependable refrigeration to the numerous fixtures.

The dining car's extra demand for electrical power is guaranteed by an additional 40 kw auxiliary unit driven by a 4-cylinder Diesel engine, installed in a soundproof compartment in the car and operated when the power load of ranges, fryers, beaters and other appliances in the all-electric kitchen is heaviest.



. Modern dining comfort



Cut-away view of lounge car shows train's four levels.

2. Installation of telephone service: In order to provide easy communication for travelers it was decided to install telephone service in the train. This was a problem for electrical engineers. In addition to telephone installations that permit easy communications, through plug-in lines, while the train is immobile at a station, newly perfected radiophone equipment has been installed.

Similar to shipboard installations, this "ship-to-shore" type equipment enables completion of calls by combination of radio and local or long-distance telephone lines. Thus, while rolling along at 100 miles per hour or less, passengers may call home, office or friends anywhere in America or in the world—provided the train is within 25 miles of the 30 or more large cities having mobile telephone installations. (More cities are scheduled to gain such equipment shortly.)

Incoming Calls

Subject only to the same limitation, as to being within range of one of the 30 equipped cities, passengers on the Train may receive calls.

The person wishing to reach the train first asks for the long distance operator, then for the mobile telephone service operator who will put the call through. The caller should inform this operator of the approximate location of the train. As needed, intermediate telephone lines will be used to route the call to the city nearest the train, then for the last link to the train, the circuit utilizes FM (frequency modulation) radio which is static-free, even during electrical storms or under bridges and station structures. Passengers may be called to the phone from any part of the train by loudspeaker announcement.

The Train of Tomorrow is also equipped with telephones in all cars and locomotive cab for car-to-car calls, which is reserved for use by members of the crew.

3. Designing glass Astra Domes: Glass alone presented a serious problem to engineers working on the Astra Dome construction. It has not ony to be strong for safety but it must be mounted to resist torque.

Since the Astra Domes and generous window spaces throughout are dominant features of the Train of Tomorrow, engineers realized in the early design stages of the train, that a glass to meet all of the above-mentioned specifications must be used. With the assistance of technicians of the Libbey-Owens-Ford Glass Co., a special railroad Thermopane glass was developed.

Such glass takes on significant meaning when the fundamental principle of Thermopane is understood. Regular Thermopane is an insulating unit consisting of two panes of glass separated by a dehydrated air space hermetically sealed in at the factory by a metal-to-glass bond. Based on the familiar storm sash principle of wintertime window insulation, such double-glass units increase the efficiency of air-conditioning in summer

(*Continued on Page* 24)

Methods of Achieving Professional Recognition

William F. Ryan, Assistant Engineering Manager of Stone and Webster Corporation, Boston, analyzes the methods of gaining professional recognition which are open to the engineer. He compares the results which will accrue from trade unionism with those which will flow from a full acceptance of engineers as professional men by the public. He sees a hope in the young men entering the profession. He presents a challenge to our educational system and to established engineering societies.

By WILLIAM F. RYAN

Before seeking professional recognition for engineers we must first establish the thesis that engineering is a profession and not a trade. There is nothing individious about the distinction. It does not imply that the engineer is any "better" in the sight of God or man than the carpenter, the plumber, or the operator of an automatic machine. It does imply however that his vocation is on a higher intellectual plane, and that his work is not subject to any standardized measurement of production or value. By education he has acquired greater knowledge of science and the arts than the tradesman, and by training and practice he has acquired the ability to exercise independent judgment and discretion in the application of that knowledge. In short, he has equipped himself to render a greater service to his fellow men.

Profession, Not a Trade

I believe I can proceed on the assumption that this thesis, "Engineering is a Profession and not a Trade," will not be challenged in this company. I cannot believe that you are proposing that thousands of boys, possessing the keenest young minds in our nation, should spend six years in institutions of higher learning to learn a trade. I warn you they will not do it, If, through our own blindness, engineering degenerates into a trade, boys of the type who now study engineering will transfer to the pure sciences, to business administration, or to some other opportunity for higher service, and we shall never again be able to bridge a gap such as that which existed between the laboratories of Berkeley and Chicago, and the destruction of Hiroshima.

Thesis Challenged

Irrefutable as this thesis may seem to us, nevertheless it has been challenged and is being challenged by people of too much importance for us to brush aside. It has been challenged by some employers, by many politicians, and by many of the brilliant young intellectuals who administer our labor laws. Worst of all, by their conduct and mental attitude, their own professional status is challenged by many engineers!

It is challenged by young engineers who come out of our colleges and voluntarily join a trade union. In their basic philosophy of restricted production, three men to do the work of one, standardization of function and standardization of remuneration, the trade unions, as we know them, are so far from the engineer's conception of his function in life, that no man with a knowledge of the facts and a real conception of professional obligations could consider alliance with them. The modus operandi of the American trade union is as foreign to professional conduct as the Nazi Gestapo is to the normal processes of democratic government. Any major movement of engineers into trades unions is professional suicide.

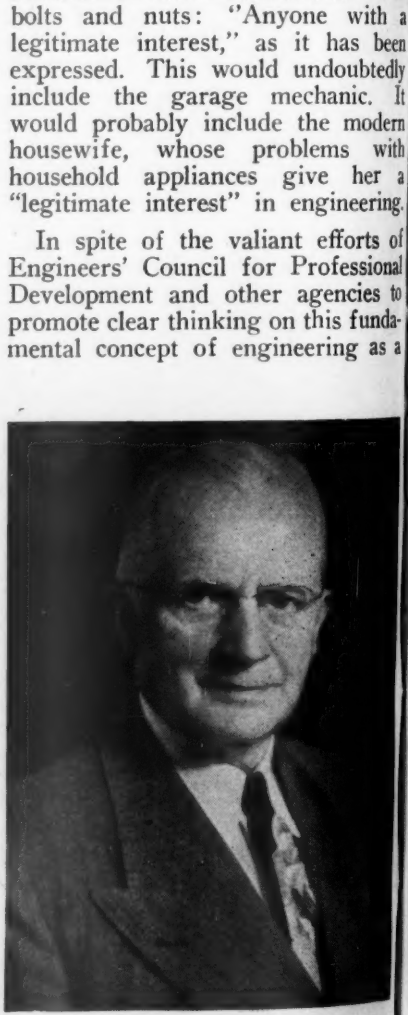
Appeal of Trades Unions

The appeal of the trades unions to engineers can be successful only in the case of ill-instructed young men and of older men who have failed in their vocation. In most cases they have failed because they have not applied a professional concept to their engineering work. The young men we can do something about. The recruits are still in your hands. They can be sent into industry with a genuine sense of professional obligations and the means of achieving professional recognition. This is your task. No more urgent problem lies before you. I know it will be solved and quickly.

The Greatest Obstacle

The greatest obstacle to our professional recognition is probably the older men who are not failures, but who, on the contrary, are acknowledged leaders of our profession, who nevertheless by their mental attitude and conduct do most to challenge the thesis that engineering is a profession. These are men whose own personal recognition is secure, won in days of really free enterprise, but who refuse to recognize the problem of young men starting their careers under present conditions. Their group consciousness, so far as it exists at all, is confined on the one hand to the elite of the profession, or on the other hand is so broad that it would include every American whose interest in engineering is sufficient to desire standardization of bolts and nuts: "Anyone with a legitimate interest," as it has been expressed. This would undoubtedly include the garage mechanic. It would probably include the modern housewife, whose problems with household appliances give her a "legitimate interest" in engineering.

In spite of the valiant efforts of Engineers' Council for Professional Development and other agencies to promote clear thinking on this fundamental concept of engineering as a



WILLIAM F. RYAN

Editor's Note: This article is based on a paper presented at a Conference of E.C.P.D.-S.P.E.E., St. Louis, June 20-23, 1946. Reprinted from Journal of Engineering Education.

profession, many of our recognized leaders think of engineers as a heterogeneous group, and engineering as an amorphous abstraction. Only a few months ago a committee of eminent engineers made a recommendation to the Executive Committee of a Founder Society. The recommendation may have been wise enough, but the reason assigned by the majority of the committee was "There is no generally accepted definition of a profession or of professional employment."

Definition of Profession

There is, of course, no lack of definitions of profession or of professional employment. They were defined, fundamentally, by the American Medical Association before most of us were born. They have been defined technically, for engineers, by the laws of 47 states, and they have been defined comprehensively and authoritatively by Committee on Professional Recognition of the Engineers' Council for Professional Development. These definitions, quoted from the 1945 annual report of E.C.P.D., are appended to this article.

Securing Acceptance

Nevertheless, our committee of eminent engineers may be right when they say there are no *generally accepted* definitions of a profession or of professional employment. I submit then that the first step in achieving professional recognition is to secure general acceptance of these definitions. Again we must begin with acceptance by the engineers themselves, and again the recruits are in your hands. They must come out of our schools with a knowledge of the attributes of a profession and the obligations of a professional practitioner.

The technological excellence of our engineering schools is so high that I used to wonder what you gentlemen talk about when you gather to consider its improvement. I perceive, however, that you find plenty to talk about that has nothing to do with technology. The pages of your *Journal* were recently enlivened by the query "Are You Teaching the Engineering Facts of Life?"* Well, are you? The author wanted to know if your boys are learning about labor unions for engineers. I can answer that one. They are learning a lot about the National Federation of Technical Engineers, Architects and Draftsmen's Unions, affiliated with the A.F. of L., and they are learning it from the Union itself. I have here one of their bulletins which announces "Student Headquarters Local No. 500—Available to students in the technical phases of engineering and architecture who are actively enrolled in a school, college or university of recognized standing and for a period of apprenticeship thereafter. The student initiation fee is $3 and the dues 50c per month, payable four months in advance." Note that elegibility is limited to students in institutions "of recognized standing." You may wish to inquire whether your particular school is accredited by the A.F. of L., and if so, why.

*By E. A. Holbrook, *Journal of Education*, Vol. 36, page 155.

Do Students Know?

The author asked pertinent questions as to what the boys are learning about legal registration as professional engineers or engineers in training. I will come back to that, but in the meantime, I wish to ask a question of my own. "Do your students know what a profession is?" I know that many of my contemporaries have only the foggiest notion. But are the new recruits, the leaders of the future, grounded in that essential concept?

Too many of us think of professional status only in terms of prerogatives, remuneration, and public esteem. Those are the fruits, not the roots, of professional recognition. If you will examine the E.C.P.D. Committee's definition of a profession and professional practitioners, you will observe it is almost entirely a matter of service, unselfishness and high ideals. Professional recognition flows only from the faithful discharge of those obligations and, without an understanding of this fundamental requirement, the pursuit of professional recognition is a hopeless quest.

No Vows of Poverty

There is nothing visionary or impractical in this idealistic concept. It is the keynote of the medical profession and is carried to such an extreme that the doctor forgoes all personal profit from his own medical discoveries or inventions because he believes such altruism is in the interest of public health. Yet the doctors are utterly practical about it. After declaring that public welfare transcends all consideration of personal profit, their Code of Ethics proceeds with two pages describing the doctor's obligation to his patients, and twelve pages describing his obligations to other doctors. Devotion of a profession to the public interest requires no vows of poverty by its practitioners.

While the engineer's work fulfills all the requirements of a profession as defined by the E.C.P.D.'s Committee, his personal conduct falls far short. First in the matter of group consciousness, which the E.C.P.D.'s Committee specifies as an important attribute of a profession; in some eminent engineers it is completely lacking, in others it is too narrow. It is confined to mechanical engineers, or to illuminating engineers, or may be even more restricted; for example, to designers of steel bridges or to teachers of thermodynamics. In other cases the group consciousness is much too broad; this is the school of thought which embraces "All having a legitimate interest" in engineering.* These are the engineers who have so much trouble in defining professional employment, and who are responsible for much of the haziness in the public mind as to just who are engineers and who are not.

Extent and Limitations

Now a profession is not an abstraction. It is a group—a group of *professional men.* The engineering profession is a group of *professional engineers.* If the first step in achieving professional recognition is to grasp what a profession is, then perhaps the second step is to grasp the extent and the limitations of the group who constitute our particular profession. I submit that this group includes all professional engineers and that it includes no others except the young men in colleges and apprenticeships who are in training to join the ranks of the professional engineers. It cannot include people, regardless of their employment or their "interest" in engineering, who are not, and have no hope of becoming, professional engineers.

Who, then, are these professional engineers? This brings us to the final attribute of a profession, as defined by the E.C.P.D.'s Committee: It should have a legal status.

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*See: "A National Spokesman for Engineers" by A. B. Stickney, *Journal of Education*, and numerous other publications, 1946.

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The profession of engineering has technically a legal status in 46 of our states, and in every province of Canada. But has it a legal status in the mind of the engineer? In Canada yes, very definitely. But in this country no, at least if we are to judge by the attitude and example of many of the acknowledged leaders of the profession. Yet before we achieve professional recognition we must accept this concept of legal status. We must regard a certificate of registration in the same light as we regard our college diplomas, which, after all, add nothing to our knowledge, but which certify to all and sundry that we possess a certain amount of it. The certificate of registration adds nothing to our knowledge, but it does certify that we know how to apply it.

Legal Registration

Again we can profit by the Doctor's example. I do not know how many physicians may have opposed registration when the states first required it by law. Possibly some of the most eminent physicians were as scornful as many of our leaders are now, but the present day practitioner knows that legal registration is the chief bulwark of his professional recognition.

The final attribute of professional practitioners as defined by the E.C. P.D.'s Committee is: "They should be members of professional groups and they should carry their part of the responsibility of advancing professional knowledge, ideals, and practice."

Wartime Experience

If I have wearied you with repeated references to the doctors, it is because they have achieved the professional recognition to which we aspire, the kind of recognition which permitted drafting a doctor into the armed services only on condition he was made at least a first lieutenant while engineers were being sent to boot camp as apprentice seamen. They have achieved the kind of recognition which kept our medical schools fully populated while engineering colleges were stripped of all but the physically unfit.

This kind of recognition was not forced upon the doctors by a grateful public. It was won by faithful discharge of professional obligations, and by intelligent organization, first to determine exactly what these obligations are, second to enforce their faithful observance, and third to secure the recognition to which the faithful discharge of such obligations is entitled. This organization is the American Medical Association, with its component societies in every state and territory of the United States, and with local chapters throughout each state.

AMA Organization

The State Society is what the doctor joins and the organization to which he pays his dues, but membership in the National Society and a District Society follows automatically. It is in the District Society that he meets with other members of his profession for discussion of professional problems. There are eighteen of these District Societies in Massachusetts, each of which is a relatively small local group, interested in common problems, and united to work together for the benefit of the public in their community, and incidentally for the benefit of themselves as professional men. These several District Societies form the Massachusetts Medical Society. Similar District Societies in the 47 other states, all the territories and the District of Columbia combine with the Massachusetts Medical Society and with the representatives of the Medical Corps of the Army, Navy and Public Health Service, to form the American Medical Association. In this manner, every registered practitioner under the American flag is eligible for membership. Every doctor is united with every other doctor to maintain his professional interests in his own locality, in his state and in the nation. The delegates who govern the American Medical Association are elected, in numbers proportional to their membership, by the State Societies, and delegates are also appointed by the Medical Corps of the Army, the Navy, and the Public Health Service. The Association operates effectively through a Board of Trustees, several Bureaus and numerous Councils and Committees. Their avowed object is to protect the public in anything and everything that has a medical aspect, to oppose unwise legislation, to expose false remedies, to promote health habits, to spread medical knowledge and to establish standards of medical ethics. So far as I know, no other medical group concerns itself with such problems. While some doctors join one society and some another for technical purposes, they leave to the A.M.A., and to it alone, their professional and economic problems. Incidental to a genuine and invaluable public service, all the more effective because of fundamentally unselfish objectives, they protect all doctors individually and collectively, from any attack on their professional prerogatives, whether by Government, industrial or financial groups, or by individuals.

I am presenting the American Medical Association as a model of professional organization. Actually the A.M.A. sponsors technical activities as well. These are handled through the Scientific Assembly, and the member must pay additional dues if he cares to participate in that work. As with the engineer, however, the doctor has found a need for more and more highly specialized societies. Eighty-nine of them, on the national level, are listed in the latest medical directory. Technically, the medical profession is a victim of the same fragmentation which afflicts us, but professionally it has one group, one spokesman, representing all registered practitioners, and nobody else belongs. No nurses, no orderlies, no hospital janitors, no pharmaceutical manufacturers, not even unregistered holders of medical degrees.

Professional Organization

How is the engineering profession organized for professional objectives, that is, to determine what its professional obligations are, to enforce the discharge of these obligations by its practitioners, and to win the recognition to which the discharge of these obligations is entitled?

At this moment only God knows how we are organized for those objectives. The Engineers' Joint Council, one of the most important elements in whatever organization we have, has a committee and three subcommittees trying to find out.

The latest issue of "Who's Who in Engineering" (1941) lists 71 national organizations as "engineering societies." All of them have engineers among their members, no doubt, and all of them have activities of technical interest to engineers, but of this group, judging by their names, only 40 should really be considered engineering societies and in only one is membership constitutionally limited to professional engineers. At least 30, either by their constitutional statement of objectives, or by their activities on the national or local level, appear to be interested in the professional status and economic welfare of the engineer, as well as the technical advancement of their own specialized branch of engineering.

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New Factors Considered In Reexamining Compton Report

Are the conclusions reached by the Compton Committee as a result of its study, "The Outlook in the Demand for and Supply of Engineering Graduates" valid? Enrollment in engineering schools during the fall of 1946 seems to indicate that they need revision—and that engineering schools might be more selective in accepting students. More important, perhaps is the question: In the light of these facts should engineering colleges revise their curricula now?

By HENRY H. ARMSBY
Specialist in Engineering Education, U. S. Office of Education

At the 54th annual meeting of the Society for the Promotion of Engineering Education (now the American Society for Engineering Education) in June, 1946, a committee of the Society under the chairmanship of Dr. K. T. Compton presented a report entitled "The Outlook in the Demand for and Supply of Engineering Graduates." This report, which is referred to in this discussion as the Compton Report, represented a sincere effort to estimate the future demand for and supply of engineering graduates in the United States, as an aid to the engineering colleges in their planning for the future.

The Compton Report

The Compton report covered only the six major fields of engineering—aeronautical, chemical, civil, electrical, mechanical, and mining-metallurgical — without any implication that the other fields are less important. Only the needs for engineering graduates within the United States were taken into account, although the committee recognized the great demand which will be made on the American engineering profession to help in the reconstruction of the devastated areas of the world.

One hunderd twenty-five industrial companies broadly representative of the nation's industrial organization completed and returned questionnaires sent out by the committee, giving certain information about their past employment of engineers and estimates of their future needs. The returns to these questionnaires are given in detail in the report, which appeared in the *Journal of Engineering Education* in September, 1946 They show several very interesting trends, one of which is the pronounced increase in the emphasis being placed on research and development by the companies answering the questionnaire. Practically without exception these companies had increased their ratio of research engineers to total engineers since 1938, and expected to increase it still further in the future. The number of engineers engaged in research and development had increased by 82 percent from 1938 to the time of the study, while those employed in production, management, and sales had increased by only 36 percent. The ratio of research engineers to total engineers in 1938 was 0.76; at the time of the report it was 1.01; and the ratio among prospective employees was 1.44. Not only were the companies increasing the ratio of research engineers to total engineers, but in the research field they were also increasing the percentage of engineers holding advanced degrees, while the opposite was true in the production field.

Industrial Employment

The returned questionnaires represented a sampling of the industrial employment of engineers, but unfortunately the committee did not know what fraction of American industry was represented by the 125 companies. The committee was therefore able to use the figures from industry only as indices and qualitative measures.

To arrive at a quantitative measure of needs the committee turned to the Bureau of Labor Statistics of the U. S, Department of Labor, which at the time was engaged in a study of the need for engineers. The Bureau of Labor Statistics had computed the ratio of engineers to total employment in each of the nation's principal industrial activities, and had estimated the total employment in each of these activities under conditions of "full employment." The committee felt that it was conservative in assuming that these ratios would be at least as high in the future as in 1940, in spite of the fact that their values, after increasing from 1930 to 1940, had decreased from 1940 to 1944.

The 1940 census shows that the total number of employed persons in the United States in 1940 was about 45 million, of whom 246 thousand were engineers (in addition, there were 15 thousand engineers unemployed in 1940). Under conditions of "full employment" the Bureau of Labor Statistics estimated total employment at 57½ million persons. Using the 1940 ratios in the various industrial activities the "full employment needs for engineers were found to be 337 thousand engineers.

Total Attrition

The committee assumed further that "full employment" would be achieved by 1950. Since there were 261 thousand engineers in 1940, 76 thousand must be added during the decade 1940 to 1950, in addition to the number needed to offset attrition due to death, retirement, and leaving the profession.

Total attrition was estimated to be 78 thousand for the decade, making a total of 154 thousand additional engineers needed during the decade. According to annual reports of SPEE about 57 thousand first degrees were granted from 1940 to 1945, and it was estimated that 7 thousand degrees would be conferred in the Spring of 1946, making a total of 64 thousand degrees granted through 1946. There would therefore be needed between 1946 and 1950 an additional 90 thousand engineers, or about 23 thousand per year through 1950.

Annual Increase

The committee's estimated annual need is about 9.4 percent of the number of engineers employed in 1940.

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* Talk delivered before the Engineering Division of the Association of Land-Grant Colleges and Universities, December 16, 1946, reprinted from the *Journal of Engineering Education.*

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The industrial questionnaires indicated an estimated need for annual increases of about 17 percent of present employment. The difference between these estimates is at least partially accounted for by the fact that in an individual company there is a fourth kind of attrition which does not enter into the national picture—that of men transferring from one company to another. The fourth type of attrition is almost impossible to measure but should be considered in comparing the Bureau of Labor Statistics and industrial data.

The committee listed several reasons for believing that this estimated need of 23 thousand engineers per year for the next four years might be too low, and pointed out that the 23 thousand per year is a short-term requirement. After full employment is achieved the annual need for engineers will be only the number needed to care for the small increase in population, plus the number made necessary by further increases in the ratios of engineers to total employment, plus replacements. This need was estimated at about 18 thousand per year, which is 50 percent above the number the engineering colleges were graduating prior to the war.

Both the industrial questionnaire and the opinion poll, which was conducted by representatives of the American Telephone and Telegraph Company, bore out the increased dependence of industry upon engineering and indicated that future needs for engineers would be much larger than past needs.

Industry's Need

The report called attention to the large need in industry for semi-professional workers of the type provided by ESMWT* courses and by technical institutes. The committee estimated that the short term needs for technical institute graduates will approximate 75 thousand per year, and expressed doubt as to the ability of the nation's technical institutes to meet this demand.

In its study of the prospective supply of engineering graduates to meet these needs, the committee estimated the maximum capacity of engineering schools in the United States to be 155 thousand, or 37 percent above the previous maximum enrollment of 113½ thousand in 1942-43. It was assumed that the number of first degrees granted would continue to be 53.8 percent of the number of registered freshmen four years earlier, as it was prior to 1941, and that the corresponding ratios for sophomores and juniors would continue to be 64.7 percent and 71.8 percent respectively. It was also assumed that the freshmen enrollment in engineering would bear the same proportionate relation to total undergraduate enrollment which obtained in 1941, namely 36½ percent, which would mean freshmen classes for 1946 and 1947 of 56½ thousand, on the basis of a total enrollment of 155 thousand. Certain assumptions were made as to the proportion of veterans and non-veterans who would follow accelerated curricula.

* Wartime short courses.

Engineer Shortages

Based on these assumptions and on the estimate that the current deficit in engineering graduates was 8 thousand, the committee worked out a tabulation showing the expected numbers of first degrees to be granted during each year up to and including 1952. (See page 38 of the printed report of the committee.) Starting with the deficit of 8 thousand and adding the 23 thousand estimated as needed in 1946 gave a total demand for 1946 of 31 thousand, which could be only partially filled by the 7 thousand first degrees to be granted in 1946, from which must be subtracted 1½ thousand whom it was assumed would enter graduate schools. This left a net deficit for 1946 of 25½ thousand. Continuing by this process the committee arrived at the conclusion that the deficit of graduate engineers would be filled by 1952, and pointed out that "This means that the need for continuing engineering education at an overload level will lessen beginning with the entering freshman class in 1949.."

Enrollment in Fall of 1946

The Compton Report listed a few of the many uncertain factors which influence the future needs for and supply of engineers, and pointed out that the limit of reliability of any such estimate must necessarily be rather wide. However, when this report was presented few responsible persons in the field of education foresaw the tremendous numbers of veterans who would seek college admission in the fall of 1946. The estimates of the committee as to the prospective supply of engineers were based on what the engineering schools had stated to be their maximum capacity of 155 thousand students, including 56½ thousand engineering freshmen. Actual enrollment this fall is about 223 thousand, including about 92.6 thousand freshmen! These are estimates based on data reported to the Secretary of A.S.E.E. by the institutions which up to December 1, 1946, had submitted complete reports differentiating veterans from non-veterans. Details are set forth in the tables which accompany this discussion.

Enrollment Estimates

Table I contains estimates in thousands of students of the enrollment in all colleges and in engineering colleges for November, 1945, and November, 1946. The figures covering all institutions are taken from a report of the Research and Statistical Service of the U. S. Office of Education, based on a sampling survey believed to be accurate within 5 percent. According to these estimates, college and university enrollment has more than doubled since last year. The enrollment of men is nearly four times that of last year, and of veterans 20 times that of last year, while the ratio of veterans to all men has increased from 14 percent to 77 percent.

The second section of Table I, dealing with engineering schools, contains estimates of the total engineering enrollment in the United

TABLE I

Comparison of Enrollments in Engineering and All Higher Education, 1945 tnd 1946

(Estimates in Thousands of Students) (Prepared by Henry H. Armsby, U. S. Office of Education, from estimates prepared by the Research and Statistical Service of the U. S. Office of Education and data supplied by the American Society for Engineering Education.) December 6, 1946.

Enrollment	November 1945	November 1946	Ratio of 1946 to 1945
All Institutions			
Total Enrollment	952.0	2078.1	2.18
Men	370.0	1417.6	3.84
Women	582.0	660.5	1.13
Veterans	50.0	1080.4	20.00
Ratio of Veterans to Men	14%	77%	5.50
Engineer Schools			
Total Enrollment	65.3	223.0	3.40
Men	47.3	222.0	4.70
Women	1.8	1.5	0.90
Veterans	16.5	154.0	9.35
Ratio of Veterans to Men	25%	69%	2.76
Ratio of Engineering Students to all Students in Higher Education	6.5%	10.6%	1.63

States for the two years, based on the enrollment of the 90 institutions previously mentioned. These enrollments were compared with the enrollments reported by the same institutions in 1945, and in order to extrapolate them to the entire country were referred back to the same institutions in 1940, the year in which the SPEE enrollment report covered the largest number of institutions, namely 147. The assumption was made that the enrollment in these 90 institutions would constitute the same proportion of the total engineering enrollment in 1945 and in 1946 which it constituted in 1940.

A comparison of the ratios in the last column of Table I shows that the enrollment in engineering schools has increased at a greater rate than that for all colleges and universities, and that the men enrolled in engineering have increased faster than the men in all colleges. This is shown very strikingly in the last figures at the bottom of the table, which show that the percentage of engineering students to all college students has increased since last year from 6½ percent to 10.6 percent. This bears out many statements and estimates to the effect that the veterans would show a very lively interest in engineering as a result of their war experiences.

Percentage of Veterans

Table II contains in columns 1, 2, 4, and 5 the engineering enrollments in the 90 institutions on which the estimates of this report are based. Columns 3 and 6 show the percentage of veterans to total enrollment in each class and for the total of the 90 institutions.

The figures in the last column of Table II are obtained by multiplying the figures in column 4 by the factor 1.9, which is the ratio of the estimated national total of 223 thousand to the 117.3 thousand reported by the 90 institutions. The information available did not permit the computation of separate factors for the various classes.

Table III is an extension of a table presented in the Compton Report which gave the distribution of engineering students by classes for the year 1939-40 and for April, 1946. To these distributions have been added those for November, 1945, and November, 1946, computed from the SPEE report for 1945 and from the reports of 90 institutions for 1946. The Compton Report stated that in the opinion of the committee the distribution by classes in 1939-40 was about a normal one and that during the war this distribution had become badly skewed. The distribution for November, 1945 is even more skewed than that quoted by the committee for April, 1946, but it is interesting to note that the distribution for 1946 is closer to normal, and the distribution of veterans still closer, if we consider that the distribution for 1939-40 is a normal one.

Table IV is an extension of a similar table published in the Compton Report, to which have been added distributions for November, 1945, November, 1946, veterans in November, 1946, and a distribution by classes (in columns 8 to 11 inclusive). The sources of these figures are the same as for those in Table III.

It is interesting to note that the expected rush of veterans into aeronautical and electrical engineering has apparently not developed. Aeronautical engineering has actually declined since last year, and electrical engineering has declined since last April, although it is one percent higher than it was last fall. The largest increases are in civil and mechanical engineering, and this is particularly true among the veterans.

The distribution by classes is of interest, although the distribution of the freshman class probably is not very significant, since included in the 43 percent "others" are 34 percent unclassified. Many institutions do not classify their freshmen and of course many freshmen change their minds before they become sophomores. The unclassified group declines to 4, 3, and 2 percent respectively in the sophomore, junior, and senior years, so that in these years the distribution by classes is probably significant.

Revised Estimates

Table V is a revision of the table under the same title which formed a part of the Compton Report. The items marked with a single star are copied directly from the table in the Compton Report. The difference between Table V and the Compton table are of course caused chiefly by the fact that the number of new students in November 1946 is so much larger than the committee anticipated. The Compton Report made separate assumptions covering the educational plans of veterans and non-veterans. In Table V both groups are treated alike, assuming that half the freshmen and sophomores will follow an accelerated program. The survival ratios for freshmen, sophomores, and juniors are the same as those used by the Compton committee. The survival ratio for seniors is the average ratio of first degrees granted in June to senior enrollment the preceding

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TABLE III

Percentage Distribution of Undergraduate Engineering Students by Classes, 1939 to 1946

(Prepared by Henry H. Armsby, U. S. Office of Education, from data supplied by American Society for Engineering Education.) December 6, 1946.

Class	All Students				Veterans	
	1939-40	Nov. 1945	Apr. 1946	Nov. 1946	Nov. 1945	Nov. 1946
Freshmen	34.2	57.6	52.1	44.5	57.4	42.1
Sophomore	25.9	21.2	23.9	27.5	24.1	28.2
Junior	21.0	12.7	14.5	16.3	12.3	17.3
Senior	18.0	8.2	7.9	11.2	6.0	12.0
Fifth Year	0.9	0.3	1.6	0.5	0.2	0.4
	100.0	100.0	100.0	100.0	100.0	100.0

TABLE II

Undergraduate Enrollments in 90 Engineering Schools by Classes, 1945 and 1946

(Thousands of Students)

(Prepared by Henry H. Armsby, U. S. Office of Education, from data supplied by American Society of Engineering Education.) December 6, 1946.

Class	November, 1945			November, 1946			1946
	Total (1)	Veterans (2)	% Vets (3)	Total (4)	Veterans (5)	% Vets (6)	Total ×1.9
Freshman	16.9	5.1	30%	48.8	32.7	67%	92.6
Sophmore	5.7	2.1	37%	30.2	21.8	72%	57.5
Junior	3.6	1.1	31%	17.8	13.4	75%	33.8
Senior	2.0	0.5	25%	12.3	9.2	75%	23.4
Fifth Year	—	—	—	0.4	0.3	75%	0.8
Regular Students	28.2	8.8	31%	109.5	77.4	71%	208.1
Other	4.7	0.7	15%	7.8	3.7	47%	14.9
Total	32.9	9.5	29%	117.3	81.1	69%	223.0

TABLE IV

Percentage Distribution of Undergraduate Engineering Students by Curricula, 1910 to 1946

(Prepared by Henry H. Armsby, U. S. Office of Education, from data supplied by American Society for Engineering Education.) December 6, 1946.

Curriculum	All Students							By Classes November 1946				Veterans
	1910-11 (1)	1920-21 (2)	1930-31 (3)	1940-41 (4)	Nov. 1945 (5)	Apr. 1946 (6)	Nov. 1946 (7)	Fresh. (8)	Soph. (9)	Jun. (10)	Sen. (11)	November 1946 (12)
Aeronautical	—	—	2.7	3.7	4.8	4.9	3.2	2.8	4.1	4.3	4.8	3.3
Chemical	2.9	*11.1	8.8	16.0	10.0	9.6	9.2	6.8	11.0	12.5	14.9	9.2
Civil	26.0	17.1	15.8	11.1	11.4	10.9	14.9	13.6	18.4	17.0	15.5	18.1
Electrical	18.0	18.2	21.3	15.4	16.1	20.5	17.1	15.9	21.8	21.4	17.6	17.3
Mechanical	21.0	22.7	15.8	28.4	18.9	21.2	21.1	16.3	26.0	28.0	30.8	23.4
Mining and Metallurgical	8.7	6.2	2.4	4.5	1.9	2.1	1.9	1.5	2.2	3.0	2.8	2.5
Other	23.4	24.7	33.2	20.9	36.9	30.8	32.6	43.1	16.5	13.8	13.6	26.2
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

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November, as taken from the SPEE reports for 1939 to 1943.

The numbers of new students to which the survival ratios are applied need a word of explanation. The number of freshmen is taken directly from Table II—namely the enrollment reported in 90 schools multiplied by 1.9. For the sophomores it is assumed that ⅓ of the indicated mortality of 46.2 percent has taken place since last spring, and that therefore there are now on our campuses 34.4 thousand sophomores who were included in the 40.7 thousand freshmen last April. Since we have a total of 57.5 thousand sophomores this fall there must be 23.1 thousand sophomores who were not on our campuses last spring.

For juniors and seniors it is assumed that ½ of the indicated mortality has occurred since last spring. If this assumption is correct there are now on our campuses 15.4 thousand juniors and 9.8 thousand seniors who were on our campuses in April as sophomores and juniors respectively. Subtracting these numbers from the totals for these classes as shown in Table II gives the figures shown in Table V.

The rest of the computations involved in Table V follow the procedures used by the Compton committee, but lead to quite a different conclusion, because of the nearly 100 thousand students now on our campuses in excess of the number anticipated by the committee.

Surplus of Engineers

The table in the Compton Report indicated that the shortage of engineers in this country would be met by 1952, and that "the need for continuing engineering education at an overload level will lessen beginning with the entering freshman class in 1949." The estimates in this reexamination indicate a surplus of engineers in the United States in 1949. Actually, the over-supply may well become evident in 1948, as will be pointed out. In either event, it seems that the engineering colleges are facing some serious problems—not in 1949, but *now*.

Possible Errors in New Estimates

Before discussing the problems arising from the present enrollment in engineering colleges, it may be well to discuss some of the many possible errors in the estimates contained in this discussion, which might easily change the small deficit estimated for 1948 into a surplus.

1. Only 147 schools were considered in deriving the factor 1.9 by which the enrollments in 90 schools were multiplied to obtain the estimates of total enrollments in engineering schools. However, very few large schools are omitted from this group, and therefore this error should be very small, and is probably offset by a small error in the SPEE figures for 1940 which was detected after completion of Table I.

2. The number of degrees granted in 1946 was estimated by the Compton committee at 7.0 thousand. The number reported by the 90 schools used in this study is 4.5 thousand. If this be multiplied by the factor of 1.9 the result is 8.6 thousand, an increase of 1.6 thousand over the committee's estimate.

3. The estimated shortage of 8 thousand engineers in 1946 should not have been used, since it was automatically included in the estimate of 90 thousand engineers needed by 1950.

4. The survival ratios used in the Compton Report may well be too low. If so, the number of graduates will be larger than is indicated in Table V.

It is almost universally agreed that the veterans on our campuses are doing a better grade of work than the average pre-war student did, because of their added maturity and earnestness of purpose. They also have greater economic security, because of the provisions of the G. I. Bill. On the other hand the fact that they are older and that many of them are married will have a tendency to make the academic mortality among them increase.

The survival ratios will be affected to an even greater extent if the present pronounced trend toward engineering education, as indicated in Table I, continues. The ratios were computed from pre-war enrollment and graduation statistics, and therefore included an allowance for the students who transferred to engineering colleges from other institutions. But if present large enrollments and

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TABLE V

Projected Production and Deficit of Engineering Graduates
(Thousands of Graduates)

(Prepared by Henry H. Armsby, U. S. Office of Education, from data supplied by American Society for Engineering Education.) December 6, 1946.

Production	1946	1947	1948	1949	1950
Of those registered in April 1946					
*53.8% of the 40.7 freshmen	—	—	10.9*	11.0*	
*64.7% of the 18.7 sophomores	—	6.0*	6.1*	—	
*71.8% of the 11.4 juniors	—	8.2*	—	—	
Of the new students in November 1946					
53.8% of the 92.6 freshmen	—	—	—	24.9	24.9
64.7% of the 23.1 sophomores	—	—	7.4	7.5	
71.8% of the 18.4 juniors	—	—	13.3	—	
83.0% of the 13.6 seniors	—	11.3	—	—	
Total first degrees granted	7.0*	25.5	37.7	43.4	24.9
Less number entering graduate school	1.5*	1.0*	—	—	—
Net number available for employment	5.5*	24.5	37.7	43.4	24.9
Deficit to date	8.0*	25.5*	24.0	9.3	(—11.1)**
Annual Demand	23.0*	23.0*	23.0*	23.0*	18.0*
Total demand	31.0*	48.5	47.0	32.3	6.9
Available for employment	5.5*	24.5	37.7	43.4	24.9
Cumulative deficit to date	25.5*	24.0	9.3	(—11.1)**	(—18.0)**

*Copied from Compton Report. **Surplus.

Legislative Committee's Monthly Report

Now that the legislative fireworks are over and the Hartley-Taft labor bill has become law despite the President's veto, it is time for engineers to examine their gains under the new law. Legislative Committee Chairman Ray Fuller herewith presents his appraisal of the meaning of the new law.

Dear Fellow Member:

Now that the country is operating under a greatly revised labor law it behooves us to ask several pertinent questions insofar as the application of the new law to professional engineers is concerned. The foremost question, of course, that one is apt to ask is, "how will it work out in practice?" That is an inquiry which will best be answered in the light of actual experience and any attempt to prejudge the results must be highly speculative. A more fruitful question, and one subject to a more accurate analysis is, "does the new law provide the protection that the profession requested?"

Three Main Points

The testimony of the joint panel of the profession before the Senate and House Labor Committees, in which NSPE participated, listed three main points which were stated to be of fundamental importance for inclusion in any legislation which established standards for collective bargaining between employees and an employer.

Because of their close relation the first two points are listed below and discussed together.

Point 1—"Any group of professional employees, who have a community of interest and who wish to bargain collectively, should be guaranteed the right to form and administer their own bargaining unit and be permitted free choice of their representatives to negotiate with their employer."

Bargaining Agents

Point 2—"No professional employee, or group of professional employees, desiring to undertake collective bargaining with an employer should be forced to affiliate with, or become members of, any bargaining group which includes non-professional employees, or to submit to representation by such a heterogeneous group or its designated agents."

These points are covered in Sections 9 (a) and (b) of the Bill which provides that representatives designated or selected for the purposes of collective bargaining by the majority of the employees in a unit appropriate for such purposes, shall be the exclusive representatives of all the employees in such unit for the purposes of collective bargaining in respect to rates of pay, wages, hours of employment, or other conditions of employment. This statement is followed by the all-important proviso that the *Board shall not decide that any unit is appropriate for such purposes if it includes both professional employees and employees who are not professional employees* unless a majority of the professional employees vote for inclusion in a heterogeneous group. Therefore, it *would appear that points 1 and 2 of the objectives have been fully met.* Professional employees would have a separate ballot in the elections for a bargaining representative and could not be forced to vote with a group controlled by non-professionals. They would thus have a free choice of turning down any organization not deemed satisfactory to represent the professional view.

RAY M. FULLER

On the other hand, if a majority of the professional employees desired to do so they could vote to affiliate with and be represented by a non-professional union. *The professionals could form their own unit, obtain an election and after receiving a majority vote of the professional employees be certified as the exclusive bargaining representative* for all the professional employes in the particular plant or business.

Of utmost importance in connection with these two points is the standard laid down to the Board to guide it in determining which employees are to fall within the "professional" category. The lack of a definition of a "professional employee" was a serious flaw in the House Bill, but happily this omission does not occur in the final bill agreed upon by the conferees. *The House accepted the definition contained in the Senate Bill without any change.*

Answer in Future

How well this definition will serve to guide the Board in determining "professionalism" will be answered only by the future. A faithful interpretation by the Board of the language should certainly present no difficulties insofar as the registered engineer who is performing actual engineering work is concerned. It should be pointed out, however, that the *definition is necessarily in terms of the work being performed,* and not in the general qualifications and background of an individual employee. This point is emphasized to make it clear that should a registered professional engineer be actually engaged in non-professional work for any reason he would not be considered a professional employee for the purposes of the Act. Also, it should be noted that the *engineer-in-training is not overlooked* in the definition, provided he is performing work related to professional work under the supervision of a professional person to become qualified as a professional employee.

No Use of Force

The *third, and final point* set forth by the profession's spokesmen was: "no professional employee should be forced, against his desires, to join any labor organization as a condition of his employment or to sacrifice his right to individual, personal relations with his employer in matters of employment conditions."

Whether this objective has been achieved might be considered a debat-

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able matter. A fair appraisal would probably indicate that this point has been only partially achieved. *The bill does forbid the "closed shop" but allows a "union shop" under certain restrictions.* Therefore, there can be no valid requirement that a person be a member of a labor organization to obtain employment, but section 8 (a) (3) stipulates "that an employer may make an agreement requiring membership in a labor organization as a condition of employment on or after the 30th day following the beginning of the employment if the labor organization is the representative of the employees and a majority of the employees eligible to vote in the election have voted to authorize the labor organization to make such an agreement." There is a further proviso that membership in the labor organization may not be denied to any person except for failure of the employee to pay his dues.

The consequence of this provision is that if a unit of professional employees vote for a "union shop" and the employer agrees to such a clause in the contract all professional employees of that employer would have to join the labor organization within 30 days after the beginning of their employment. However, there could be no agreement that a professional must be a member of the union in order to obtain the job.

As to the *second phase of point 3,* it is again questionable as to whether or not the objective was reached. Section 9 (a) provides that any individual employee or *group of employees shall have the right at any time to present grievances to their employer and to have such grievances adjusted,* without the intervention of the bargaining representative, as long as the adjustment is not inconsistent with the terms of a collective-bargaining contract or agreement then in effect; and that the bargaining representative has been given opportunity to be present at such adjustment.

The conferees felt that this provision was adequate to protect individual relations. The House Bill contained a provision to the effect that nothing in the Act was to be construed as prohibiting an employer from forming or maintaining a committee of employees and discussing with it matters of mutual interest, if the employees did not have a bargaining representative. The conferees stated that this provision was omitted from the conference agreement since the act by its terms permits individual employees and groups of employees to meet with the employer and section 9 (a) permits employers to answer the grievances. The question is whether this provision will be sufficient to assure employers that they will not be subject to an "unfair labor practice" charge if they attempt to deal with individual or groups of professional employees who are not certified. Past experience has indicated that such relations have resulted in "company union" charges against the employer, but the conferees apparently felt that the provision given above, plus the *"purified" atmosphere hoped for under the new bill* would be sufficient to avoid a repetition of past difficulties.

On the basis of the bill as sent to the President it would appear to be a fair conclusion that *the profession, as represented by the joint panel, has substantially obtained the points it set forth.* As described above, the third point was compromised in the final bill, but all who are familiar with legislative processes know that laws are the product of give-and-take between the divergent viewpoints. Even more important is the knowledge that the final answer to success or failure lies not in the words used on sheets of paper, but in the live day-by-day application of those words to actual facts and cases. The maxim, "Laws are as good as the men that administer them," is as true of this important legislation as of any that now grace the statute books.

The job of the Legislative Committee has not ended with the adoption of the new law. We must keep an alert from now on to determine how the law is working out with regard to our profession. To do our job adequately we need your help. The results of the new law will be felt in the various States at the local level. Therefore, you are urged to let our Washington office know the practical application of the new labor law to the engineering profession, as you experience it and see its effects.

Cordially yours,

Ray M. Fuller

Recently, the New Mexico Society of Professional Engineers worked unceasingly to obtain two-hundred members by the night of its Charter Banquet, at which time Paul H. Robbins, Executive Director of the National Society of Professional Engineers, presented the Society with its charter.

Up to the last minute, only 199 members had been signed up. When who should walk in the banquet hall, but Al Buck, Mayor of Albuquerquo, who gave the address of welcome to the out-of-town engineers. Immediately the Chairman of the Membership Drive knew who the 200th member would be!! Mr. Buck! Our Mayor, a registered professional engineer in New Mexico, graciously accepted the honor of becoming our 200th member. The above picture shows G. Perry Steen, President of the Society congratulating Mayor Buck while W. C. Wagner, Membership Chairman and National Director proudly looks on.

Mr. Buck, who, though owner and operator of the Rio Grande Steel Products Company, president of K.O.A.T. radio broadcasting Company, Inc., and Mayor, still finds time to take part in his profession of engineering.

Engineers as Citizens In The Atomic Age

The world has entered the Atomic Age—and this development has great implications for all peoples. But perhaps it imposes greater obligations on engineers than on any other group. Dr. Henry T. Heald, president, Illinois Institute of Technology, discusses some of these obligations, with particular reference to civic duties and educational development.

By HENRY T. HEALD

Not so long ago, a tolerance, or the maximum allowable error in the accuracy of machining steel was three-thousandths of an inch. This was in the days when governmental budgets were estimated in terms of millions of dollars; speeds ranged as high as 200 miles per hour, radio was barely out of the field of communications, and known temperatures were measured in terms of thousands of degrees.

Our civilization has moved into an era where allowances for error are smaller and our conceptions of numbers correspondingly greater. With the profilometer we now obtain an accuracy of two or three millionths of an inch. A new speed record for air travel of 618.4 miles per hour has just been set, and supersonic speeds are just around the corner. Radio has matured into electronics, to find a place of service in practically every field of human endeavor. And atomic scientists are pondering over methods to measure temperatures in excess of a billion degrees.

Orientation Problem

It is not possible for a society largely prescientific in its social attitudes to move into a state where the margins of error are so small, the material advancement so profound, without disaster, unless individuals and society orientate themselves to reality before it is too late. The maximum allowable error in the relationships between people, social institutions, and nations is rapidly diminishing as we accelerate the pace of our technological achievement. The structure of our society has become so complex that the old standards of measurement are fast becoming obsolete.

As the tolerances allowed by our social mechanisms decrease, the need for greater accuracy in thinking becomes more acute. Economic maladjustment is no longer confined to a section or even a nation, but sweeps like a plague to the four corners of the world, carrying destitution and hopelessness in its wake. So far flung, so powerful are the ramifications of labor and industry that strikes and lock-outs have become a threat not only to the conveniences of the people, but often to their very livelihood and security. And the bomb hangs over—striking fear into the hearts of those who have it, and inciting terror and consternation among those who haven't.

HENRY T. HEALD

The Small People

The tragedy of what the world faces today is that these conditions are actually intolerable to the millions of "we, the small people," as Jan Masaryk of Czechoslovakia has so aptly put it. If some super-public opinion agency could take a valid and unrestricted poll of the people of the world, in language whose meanings were equally understood, is there any doubt about their opinion of the four freedoms? Surely, too, they would overwhelmingly favor economic opportunity, industrial peace, self-government, and race equality. Would they vote for atomic war and annihilation? Hardly.

Our difficulties are due to the fact that we have yet to learn not to have class struggle, industrial strife, economic confusion, intolerance, and war. It is inconceivable that any American in his right mind would entertain the thought of wanting to drop an atomic bomb on Russia or any other country; but *fear* keeps us from divulging the secret. Frankly, I, like most Americans, am in accord with our present foreign policy on this point. Until legal safeguards, supported by thorough international inspection and adequate means are available to punish a violation by an outlaw nation or group of nations, we cannot release our knowledge of the atom bomb. At the same time, what would *our* reaction be if we knew that the most devastating weapon of all time was in the hands of a foreign power, regardless of how well-intentioned that nation might be. This condition, I submit, does not make for an atmosphere of international trust and security. And today not two or three nations, but the peoples of the world are involved.

Pessimistic View

There are those who view the present situation with complete despair. Their outlook is stoically two-valued. "Our civilization must soon reach perfection or be destroyed," they say. "Since the world is obviously in a mess, everything is going to the dogs and we can't do a thing about it." This attitude reminds me of the little jingle that was popular in our grandfathers' time.

The caveman in his fur togs
Said things were going to the dogs;

Our forefathers in the Flemish bogs
Said things were going to the dogs;

Our grandfather in his house of logs
Said things were going to the dogs;

Unless life changes, let me state,
The dogs will have a long, long wait.

In spite of the seemingly insurmountabel human problems that we face, and the apparent Babel of conflicting interests, attitudes, and sym-

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bols, there is convincing evidence that man's march is upward. In fact, the solutions to many of our perplexities will carry with them when they come some of the greatest benefits to human welfare since man began to evolve a social structure.

Never before in history have we been more fully aware of the problems or attempted to state them with more impartial discernment. To define these problems is the first step in their solution. To state them is to bring them out into the open where we may see whether they are problems in the light of realistic evaluation. Discovering that they are, we may then proceed down the long road of analysis and inquiry toward their eventual solution.

We know that there are no "absolutes," even in science, and the solutions of social problems at their best will be relative. But the scientific approach, used in its broader sense, is essential. The "allowable tolerances" in our human relationships are now reduced in proportion to our technological and scientific progress.

Critical Problems

In our own country we can agree at least that we do have critical problems. And we are well on our way to defining them in such an objective manner as to bring about some agreement in stating them. Sometimes there seems to be an unbridgable gulf in the process of resolving them. Labor and management have reached such a temporary impasse.

In the light of history, few now doubt the wisdom of regulating the excesses of those leaders of capital whose motives and actions were inimical to the public welfare, as well as to enlightened capital itself. The preferred position of organized labor under existing conditions has also led to excesses. It is certain that the public welfare must be protected, and the abuses of power by either side must be dealt with.

To view all organized labor as an evil, however, is as highly abstractive as viewing all capitalists as fat men with diamond rings and big black cigars. An intelligent capital and labor are both essential to our system of free enterprise which has produced the highest standards of living of any civilization. Freedom of opportunity for both capital and labor has been one of the foundations of this achievement. The major problems involving industry and labor can be reasonably defined; their solutions are more difficult. They must be approached objectively, with a minimum of emotion and no reprisals. Again the answers will not be "absolute" or completely adequate for all. But they will be within the area of "maximum allowable error."

Economic Dislocations

Dislocations in the economic machinery, the race question, national health, development of adequate education for present needs, are only a few of the fields in which a maze of problems continue to resist our efforts to untangle them. That all of these problems cannot be solved by law or by executive directive has been demonstrated by many of our experiences during recent years. No problems in science or engineering are solved by fanatical crusading, and there is considerable doubt whether this method meets the requirements of modern social mechanisms where tolerances are so close.

Fortunately, we are beginning to recognize the extent of our social, economic, and political problems today and to realize the inadequacy of our present methods for dealing with them. The threatening nature of these problems presses for action. For instance, the growing interdependence between nations in an intimate world of natural rivalries is a compelling inducement to seek a way out of our uncertainties. Society is now at the place where it must make its decision to achieve a higher level of cooperative living or to pay the penalty of social disintegration.

Science v. Human Relations

For some time now the position has been taken by many that science and technology have outstripped our advancement in the field of human relationships. This is a valid argument, since it can be sustained by the factual evidence which is only too apparent in the conditions which surround us. But to single out and blame the scientist and the engineer for these conditions is sheer nonsense.

There are some who would call a moratorium on research and material progress in order to give society a chance to catch up in the development of its social institutions. This viewpoint is ridiculously incongruous. It is based on the assumption that man's desire for knowledge can be turned on and off like a water faucet. The development of nuclear energy would have come without regard to social conditions. Only the necessity of war accelerated the development of *one* of its uses. Our concern is not "why did we ever split the atom?" but "what will men do with it?"

Wendell Johnson, professor of psychology at the University of Iowa, said recently:

> "Another generation of technicians and engineers with technological reflexes, incompetent to assist in dealing with the social problems which their technical competence creates is indeed a terrifying and demoralizing prospect. Most of the research workers who served as midwives to plutonium were sufficiently shocked when they saw the baby to offer their services as wardens and guards. Some of them even volunteered to drown it."

Professor Johnson might have appropriately added that the reason for their shock might conceivably have been the realization that the care and feeding of the baby would be far from scientific in the hands of those to whom it was being committeed.

Mutual Responsibility

The engineer and scientist must accept mutual responsibility with his fellow members of society for the solution of our social problems, and especially those arising out of his work. I am not willing to concede, however, that these professions have brushed off their responsibilities with "Am I my brother's keeper?" On the contrary, they have shown a serious awareness of responsibility. This is particularly true in the engineering profession. Much is being done about it. And much more needs to be done.

I should like to consider with you the engineer's place as a citizen, in the light of the current economic, social, and political conditions which we have been discussing.

Democracy is an intensely dynamic concept. True, democracy is not what any one individual, organization, or even government says it is. The constitution itself is only the general framework, a plan for democratic action.

Democracy in the United States, in reality, is the sum total of a majority of the citizens' conceptions of it—at work at any specific time. Its success depends upon an enlightened and active citizenship. Therefore, it is not the special duty or peculiar prerogative of the engineer to be a good citizen. This is incumbent upon all Americans if we are to make democracy work. I am singling out the engineer now, simply because we who are here today are engineers and are interested in how we, as individuals and as a professional group, may contribute to our

democratic heritage at home and its leadership aboard.

Civic Responsibility

Democracy begins in the precinct. The polling place is the specific location where we meet our first responsibility as a citizen. Here, directly and indirectly, we can express ourselves in all phases of governmental policy. Here we can help select good and honest leaders in our own community, knowing that such action will encourage the selection of competent men on each higher level. The ballot is not only a vote for individuals, but has an effect on problems that range from local street repairs to turning over atomic secrets to Russia. As trite as the admonition may be, our duty as good engineers and good citizens is—to vote.

The engineer must be concerned with politics. By this I am not advocating that the engineer should necessarily run for office or become a ward heeler. I am suggesting that he should participate in a political organization to the extent that he may have some share in shaping public policies and the selection of able candidates. The engineer's training peculiarly fits him to approach problems from an objective viewpoint. His counsel can be invaluable to those who are directing governmental affairs. The engineer is qualified to bring more intellect and less emotion into politics. He has a responsibility to his fellow citizens and to his country to use these talents in this way.

Group Responsibility

Engineers, both as individuals and as a professional group, have a responsibility to let their representatives know their opinions on important legislative questions. Political groups and lobbies never hesitate to attempt to influence legislation by direct personal approach. Often the only guidance our representatives have comes from professional politicians and special interest groups.

Legislators are not mind readers and do not have the time or money to canvass their constituents on all important problems. I believe that the majority of our legislators want to do a good job and to act wisely in behalf of their constituents. They need and welcome unprejudiced cooperation, especially from those who are familiar with highly specialized problems with which they have to deal.

One letter, a congressman once told me, from a constituent, expressing an opinion based on an intelligent analysis of the subject is worth more than thousands of telegrams of approval or disapproval, sent without adequate supporting evidence. The latter is usually the result of the organized effort of a special interest group. The engineer is in a strategic position to influence legislation in the interest of the general public. It is his responsibility as a citizen to do so.

National Policy Issues

If it is the duty and responsibility of the engineer to participate actively and energetically in the polical decision-making processes of our democratic nation, it is equally necessary and incumbent upon him to be well informed on economic and social principles involved in issues of national policy. Indeed, without a firm knowledge of the fundamental theoretical and practical aspects of national economic controversies, neither the engineer nor any other citizen can exercise effectively, and in the best interest of the country, the prerogatives and responsibilities of democracy. Since it seems certain that we shall be confronted, time and again during our generation, with decisions of grave and crucial import for both our national and international life, the significance of the engineer's understanding of basic economic processes becomes critically apparent.

Not only must the engineer possess a practical understanding of economic matters for proper formulation of national economic action, but he also has need of such knowledge in numerous phases of his professional business life. As an example of what I have in mind, let us take an area of domestic economic policy now very much in the public press—the field of industrial relations.

Speaking generally, industrial relations is of the utmost importance to all persons interested in and responsible for technological change and improvement in American industry. Our inventors, our technologists, our engineers, have devised and are now devising ways and means to raise the productivity or potential productivity of our nation. From such innovations in the past have come our vastly increased standard of living or "real income." From such innovations will come our increased real income of the future. Yet a little reflection will make it evident that it is not enough merely to devise and announce technological improvements; to be evolved into reality, these improvements must be translated into greater actual productivity by way of altered worker processes. To make such translation is a problem in human relations — industrial relations — a problem upon whose effective and efficient solution depends the fruition and concrete realization of technological progress. All technologists, all innovators—engineers among them —will of necessity be concerned with the field of industrial relations; they will be concerned because industrial relations constitute the funnel through which their works spring into life.

Engineers' Talents

The engineer has a responsibility to participate in civic affairs. He has many talents to bring to the service of his fellow men. In doing so he inevitably enriches his own life and adds to the prestige of his profession. I fully realize how thoroughly the demands of the engineering profession drain the time and energy of those who practice it. It is not possible to serve on every committee, every board, or every jury. But it is a duty as well as a satisfaction to serve our communities and fellow men in capacities in which we are particularly trained. Our communities abound in such opportunities. Educational institutions, hospitals, churches, organizations for good government, community development, and health activities are only a few who would welcome engineers on their board and committees. This type of service has its practical compensations also, because it provides a liberal course in adult education.

International Affairs

To the individual engineer, the prospects of participating in international affairs appears remote. It seems highly impractical to counsel the engineer to take an active part in international activities and provide no means for this participation. It may be equally futile to suggest that engineers and student engineers should acquaint themselves with the interplay of the social forces throughout the world without their being able to do something about it. If the engineer were a less adjusted person, he would be more frustrated than the white rats of the psychologist. For on the one hand, critics blame the engineer for bringing about a technological age that may result in international chaos, and on the

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other, they are condemning the engineer for not doing something about it.

In spite of the fact that the individual as such has little opportunity to express himself directly on international affairs, it is still his duty as an enlightened citizen to formulate, through critical analysis, opinions that go into the great hopper of American public opinion, for in the long run, that opinion becomes our foreign policy.

But engineers can go a step further and express their opinions, especially as a group, under circumstances where the stake is great and time is of the essence. The weight of responsible group opinion expressing a valid case was dramatically illustrated in the work of the Association of Atomic Scientists in connection with the control of atomic energy. Engineers, through their local and national societies, can express their views on vital national or international questions if they so desire. This is a direct way in which the citizen engineer and the engineering profession as a whole can make a major contribution to the solution of international problems.

Mutual Possessions

We have advanced the quality of our engineering products by closer tolerances, and have also improved the quality of our engineers by higher professional standards. Engineering has a body of knowledge and an art which are mutual possessions of those who practice it, together with a willingness to share new knowledge and new skills. It is a type of activity in which the motive of service over profit and a sense of high individual responsibility are present. There is a conscious individual and group recognition of social duty. The nature of the profession requires standards of qualifications in competency and character, standards of conduct in relation to the public, to clients, and colleagues, and a close relationship with education in maintaining these standards.

The acceptance of professional responsibility by the engineer should carry with it more control in engineering, in order that he may apply ethical standards to the exploitation of his work, as well as to its technical phases. As the professional status of the engineer grows in public acceptance and is recognized by statute, we shall probably see the engineer taking a more direct part in the control of engineering activities and their subsequent relation to the public welfare.

Engineering Education

In the general summary of our discussion I would like to conclude with some thoughts about the education of the engineer. A quick review of the points that we have covered will indicate that the education of an engineer in our present society is a big order—perhaps too big to expect of either the student or the college in the allotted period of four years. And yet the arbitrary addition of one or two more years for all students does not provide a satisfactory solution.

Here are some of the demands on the engineer today that education must attempt to fulfill. The student must have the best engineering training possible in an age when development of scientific knowledge and new techniques has been so accelerated that specialists in the fields themselves can scarcely keep abreast. The engineer should have a sufficient background in the social and economic field to understand the human problems associated with technological development and to participate in their solution. He is expected to develop into a full-founded individual of character and to make personal adjustment to a very complicated society. It is desirous that he have some interest and appreciation of the arts, for his own well being. He is told that as an engineer he has a duty to participate in civic affairs and to meet the requirements of good citizenship. He has responsibilities in his relationships with labor and management. He should have an adequate understanding of international affairs, for he is expected to assume more leadership in formulating public opinion in this field. These are not by any means all of the demands made on the engineer, but they cover the more important ones.

Responsibility to Public

I have enumerated these as *demands* of society. Actually, they are also goals for engineering education. Let us see what is being done about them. In the first place, our job is to train engineers. For that reason, the curriculum must be predominately scientific and technological. The factor which determines the aims and standards of our educational program is our responsibility to the public, to industry, and to the profession. Our methods are largely determined by the needs of our students and our obligations to them as individuals.

The report of the post-war committee of the American Society for Engineering Education (then the S.P.E.E.) suggested what should be included in the general aims and scope of the engineering curriculum. "They include," the committee pointed out, "training in the sciences basic to engineering, the rudimentary development of certain technical skills, an introduction to the engineering method of solving problems of practice, an understanding of values and costs, a sense of the art of engineering as distinguished from its science, the ability to read, write, and speak the English language effectively, a knowledge of social and human relationships, an understanding of the duties of citizenship, an appreciation of cultural interests outside the field of engineering, and indoctrination in professional standards and relations. Inherent in the accomplishment of these purposes is the development in the student of habits of accuracy and thoroughness, powers of analysis, creative ability, respect for facts, and high standards of integrity with respect to all aspects of his work."

Time Limitations

These are some of the goals which engineering education is endeavoring to achieve. Obviously, one of our most difficult problems is the limitation of time. Although effort is being made to insure more effective preparation and to develop more accurate methods of selectivity for admissions, the early work in college must be essentially introductory in nature to develop the "ability to study effectively, to think quantitatively, and to execute systematically."

The education of a *good* engineer today implies that his training includes a knowledge of the humanistic-social field, in order that he may have some background for the variety of responsibilities which will be placed upon him. This can best be achieved through a designed sequence of courses extending through his entire four years of study and requiring approximately twenty per cent of his time. The fields generally included in the humanistic-social stem of the curriculum that are essential to develop competent citizenship are English, history, economics, and government. Those that contribute to the engineer's intellectual viewpoint include literature, philosophy, psychology, and the fine arts.

There is little disagreement on the propriety or even the need of including liberal studies in the engineering curriculum. Difficutlies arise in putting the plan into operation. The time factor is by far the greatest hurdle. This is not only a problem for those who formulate the curriculum, but it is reflected in the reaction of the faculty and the students. Teachers of engineering and science are predominately specialists; their interests lie in their particular fields. There is too little time now to cover the vast amount of material that is considered essential in their courses. Generally, the engineering student's interest is primarily in the technological field. It is not surprising that he allocates the majority of his time and energy to the field which to him, at this stage, seems most important. This condition leads to the treatment of the humanistic-social stem as a sort of an extra-curricular program. In many cases the student takes only the minimum courses required or elects courses which he considers "easy credit."

Several solutions to this problem are being tried. All of these are attempts to integrate the humanistic-social part of the curriculum with engineering studies. Whatever solutions are tried, one thing seems essential—that we must not treat the humanistic-social studies as a foreign field to be given passing attention by the student as a necessary evil. As yet no way has been found to incorporate related components of the humanistic-social studies into the content of the scientific disciplines. But theoretically, the idea has some interesting possibilities.

Tolerances Diminishing

As we observe the tolerances in technology diminishing, we are also aware that the maximum allowable errors in the functioning of our human mechanisms are being reduced. The old, outmoded standards of measurement applied to our social institutions are inadequate for the streamlined speeds of modern science. We are observing a condition of fatique in our human relations that can only be rectified by redesigning the structure through the application of new principles. The need today is not for less, but for *more* science and *more* engineering applied to man and his social institutions.

Reclamation Program

AN ENGINEERING JOB

(*Continued from Page* 4)

guidance in the construction of individual units.

Unequaled Construction

The rapidity of population growth and the need for an expanded economy in the nation has served to push present construction to a volume unequaled in the 45-year history of Federal reclamation. Future design and construction activities will probably be taken forward at a similar or greater rate. The participation of all sections of the country in such projects is almost equally great. The East must produce most of the finished goods, such as generators, turbines, and gates for reclamation structures, as well as the preponderant part of the farm machinery, clothing, and countless other materials necessary to the western population. The West must reach a balanced and stabilized economy for the welfare of the nation as a whole.

The magnitude of the reclamation job ahead may be appreciated by any engineer who has had an opportunity to study the integrated plans for development of the major river basins. The largest of the basins is that of the Missouri River which occupies one-sixth of the total land area of the United States in which live five percent of the population. Eventually approximately 5,000,000 acres of land within the area are to be brought under irrigation. Proposed facilities for hydro-power production will be capable of generating more than five and a half billion kilowatt-hours of electrical energy annually for agricultural, mineral, and industrial development. Irrigation requirements alone will amount to approximately 900 million kilowatt-hours annually. Provisions for flood control will mean an annual estimated saving of $18,500,000 per year to people on the lower Missouri River.

Dams and Reservoirs

The engineering works which must be built to provide these benefits include more than 100 dams on the Missouri and its tributaries. The reservoirs created by the dams will store more water than flows from the mouth of the Missouri in an entire year. The comprehensive plan will require decades for full development, but each proposed unit, as it approaches the reality of construction, will be tested further for economic value and feasibility in competition with others.

The Colorado River basin is to be

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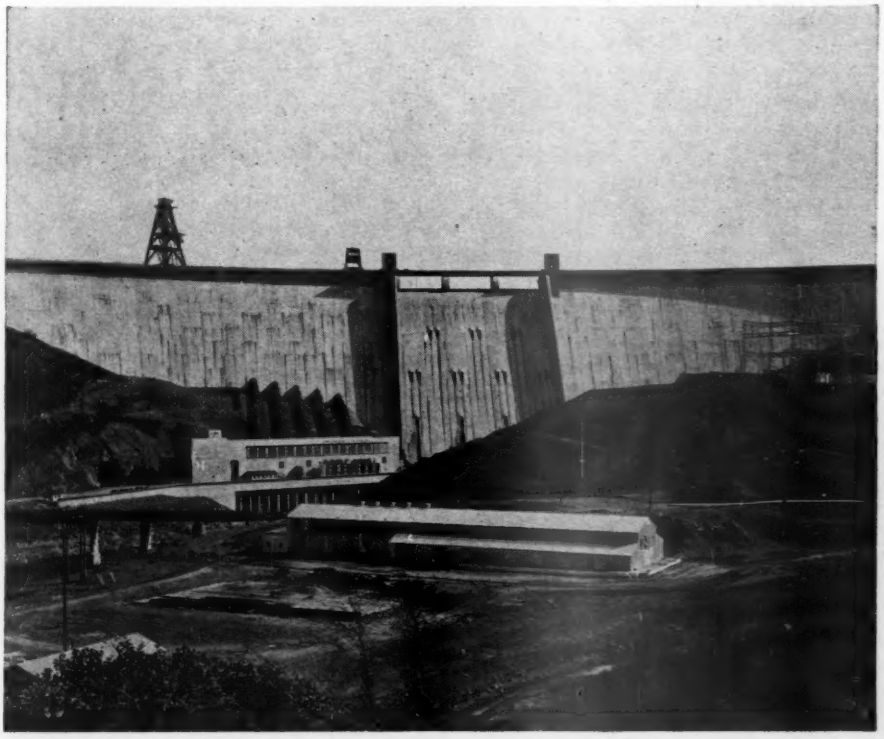
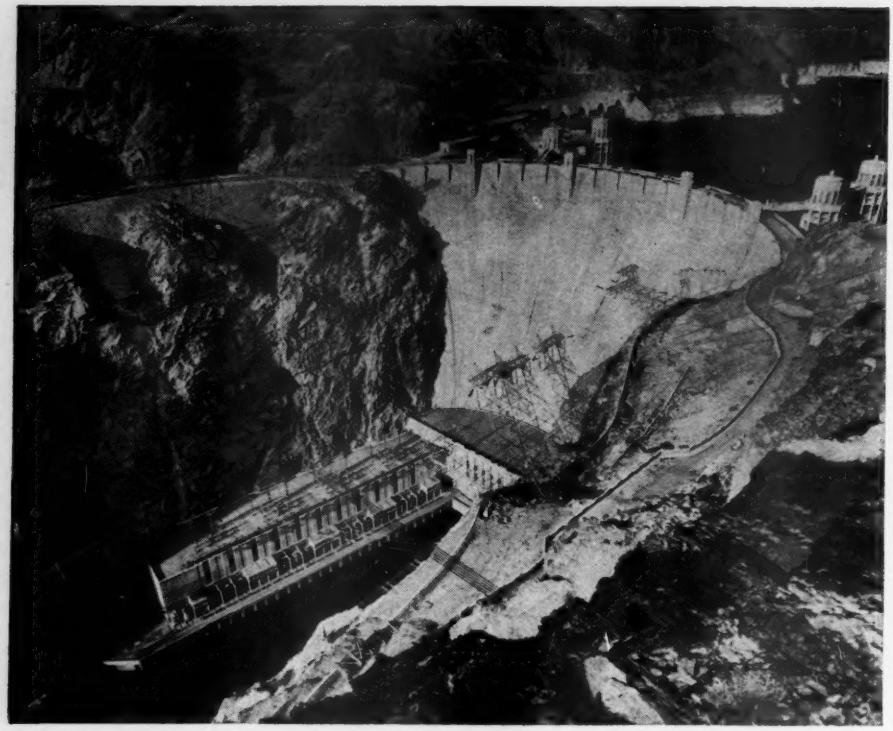


View of California's Shasta Dam Showing Bureau of Mines Experimental Laboratory in foreground.



Hoover Dam, part of Boulder Canyon Project.

(*Continued from Preceding Page*)

the scene of another great future development. The basin comprises one-twelfth of the land area of the United States. At present less than one-half of the water of the Colorado River is being utilized, and most of the reclamation work has been concentrated on the lower reaches of the river. Here Imperial, Parker, Davis, and mighty Hoover dam will form an unbroken link of structures for the control and use of the water. With the completion of Davis dam and powerplant, now under construction about 67 miles below Hoover dam, the development will be virtually complete from Lake Mead to the Mexican border. Full utilization will require conversion of the main stream into an almost continuous series of lakes extending along the 1,400 mile length of the river. A recently completed report on the comprehensive development of the basin outlines projects which would upon completion permit the irrigation of more than two and one-half million acres of dry or inadequately watered land and the generation of more than 19 billion kilowatt-hours of electrical energy annually, in addition to other benefits.

Bigger Than Hoover Dam

One of the most remarkable and as yet unauthorized schemes proposed for future development of the Colorado River involves the building of a concrete dam greater in height than Hoover dam, a continuous tunnel 78 miles in length, and an aqueduct 235 miles long. The Bridge Canyon damsite, as it is known, is about 120 miles upstream from Hoover dam. It is in a deep gorge, the walls of which rise almost perpendicularly through a vertical distance of more than one-half mile. The dam would have a height of 739 feet above bedrock, a base thickness of about 680 feet, and a crest length of 1,950 feet. A unique feature of the design is the provision for a powerplant having a capacity of 750,000 kilowatts to be installed in a huge chamber within the main section of the dam. This arangement would provide economy of construction and prevent spray interference with electrical mechanisms, in addition to providing security from aerial attack in wartime.

Water stored in the reservoir formed by Bridge Canyon dam could be used to supply additional water to an area of 600,000 acres of richly productive land in central Arizona. The 235-mile tunnel would carry the water through a divide, which separates the upper valley of the Colorado from the interior of the state.

Future projects involve transmountain diversions of which the largest would exceed the Colorado-Big Thompson project, now under construction. These contemplated plans include the Gunnison-Arkansas and the Blue-South Platte plans, both in Colorado, which would transport water from the western slope of the Continental Divide to the eastern slope for irrigation, power development, and other uses. The project will provide for the irrigation of more than 1,000,000 acres of land and the production of more than 4,500,000,000 kilowatt-hours of electrical energy annually.

25 Major Basins

The projects briefly described above are an example of some of the major undertakings planned for future construction. They serve to show the diversity and scope of problems to be faced in reclamation engineering. Space does not permit a detailed discussion of the long-range reclamation program, but some idea of the program may be gained from consideration of the fact that comprehensive surveys of 25 major river basins and some 200 investigations of sub-basins and projects have been in progress. The coordinated development of the water resources will bring irrigation to additional millions of acres. The Bureau of Reclamation program contemplates an additional installed capacity of approximately two million kilowatts of hydroelectric power to be added to the more than 2,400,000 kilowatts now installed.

Nettlesome Problems

The successful design of future engineering works for efficient and economical operation will depend largely upon the ability of the engineer to solve many still nettlesome problems. For example, there are thousands of miles of irrigation canals in the west which are unlined, thereby permitting the loss of appreciable amounts of water through seepage. Present methods and materials are often too costly for lining the canals economically. Although progress has been made, methods of combatting noxious weeds is another problem yet to be completely solved. The siltation of reservoirs, which tends to reduce their effective capacity, is receiving considerable attention now and must receive more. Improvement of irrigation methods and better design of mechanical, electrical, and other equipment for reclamation structures are fertile fields for the attention of the engineering profession.

Thus, it must be evident that the Bureau of Reclamation has a program which is a challenge both as to the tremendous physical scope of the project, and the enormous variety of engineering problems to be solved.

Industrial and Military Affairs Major Subjects of NSPE Board Action

The three most important actions of the NSPE Board of Directors during its Washington meeting were: (1) to create a new committee to study problems of industrial groups, (2) to instruct the Society's Military Affairs Committee to make a study and develop a program to bring about the most effective utilization of engineers in times of national emergency, and (3) to reemphasize the need for educating student engineers to accept their civic responsibilities.

1. **New Committee Created:** Following the Board's action in creating the new Committee, William Ryan, chairman of the Special Committee on Industrial Groups said: "The NSPE Board's decision to form a standing committee to deal with industrial problems will place the best legal, economic and social advice available in the hands of engineers and engineering groups.

"Never again will the engineering profession be subjected to the difficulties which it has suffered during the last fifteen years at the hands of professional labor organizers. Engineers (under the Taft-Hartley law) have been given the right to deal with their employers on a professional basis, comparable to the basis which exists between client and attorney. They have been regranted the right to deal with employers as professional men should deal with management. The newly created committee will maintain a constant vigilance to assure that maladministration, which some authorities say strangled the engineer under the original Wagner Act, does not pervert the intention of Congress."

Other major problems with which the new Committee will concern itself are: (a) relationships which exist between engineers who are employed in industry and those who function in a consulting capacity, (b) ethics of the professional man in industry, (c) responsibilities of the engineering profession to the public, (d) civic duties and programs which the engineer in industry must assume and foster, and (e) means of aiding newly graduated engineers and other younger engineers in adapting themselves to a professional mien and mode of thinking.

2. **Military Affairs:** A report of the Military Affairs Committee was adopted. This action means that this same committee is instructed to formulate a program on the most effective utilization of engineers in times of national emergency, which will be recommended to the government when it is completed.

In commenting on this action, Ritchie Lawrie, Jr., president of NSPE said, "The possibility of an undeclared war using atomic bombs, rockets and guided missiles makes it imperative that our government be in a position to mobilize all of our engineering personnel on a moment's notice. Delay might mean a terrible loss of life or even loss of any war in which we might become involved."

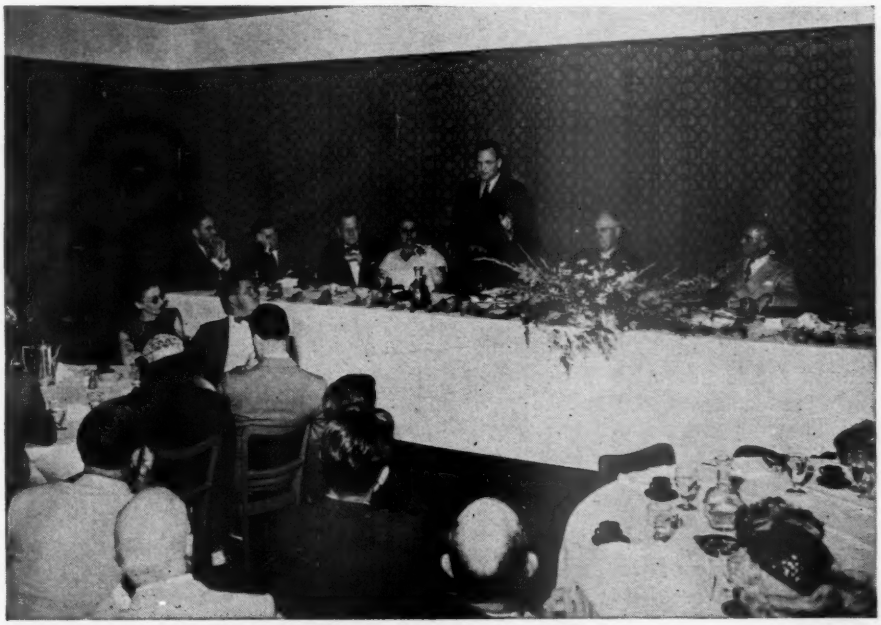
The Committee's purpose will be to draft a program which will: (a) prevent waste and misuse of qualified engineering personnel in times of national emergency, and (b) establish a close liason between civilian and military engineers, particularly during peacetime. It will also determine whether an organization that would insure better utilization of engineers during national emergencies should be established.

The Board of Directors of the National Society of Professional Engineers made many important decisions at its July 12 meeting in Washington, D. C. at the Statler Hotel. Three of these are outstanding and consequently are being reported in the July issue of the American Engineer. Unfortunately, publication schedule does not permit a full report on the Board meeting and the Secretaries Conference in the July magazine. It will be published in August.

3. **Education:** In adopting a recommendation that greater emphasis be placed on expanded curricula for engineering colleges, the NSPE Board assured a continued activity on behalf of the five year program which NSPE has publicly favored.

In commenting on this action, President Lawrie said, "The time has come when the engineering profession must abandon its traditional reticence and assume full public responsibility for new technological developments. It must take credit for the developments which it has made possible, but at the same time, it must assume a role in protecting the public from those who would unscrupulously exploit these advancements. The profession must assure that constructive use — rather than total destruction — results from its work."

Senator George W. Malone of Nevada and Congressman George P. Miller of California were guests at a dinner which was given in connection with the Board meeting.



Senator George W. Malone (Nev.) addressing NSPE Board of Director's Dinner.

THE TRAIN OF TOMORROW

(*Continued from Page 7*)

and heating in winter—both important factors in human comfort.

The Thermopane glass units used in the Train of Tomorrow Astra Domes are made up as follows:

a. The outside sheet is heat-absorbing, glare-reducing polished plate glass and is tufflexed (heat-treated or tempered) to assure extra strength.

b. The inside glass, separated from the outside sheet by a quarter-inch dehydrated insulating air space, is made up of special laminated safety glass (two panes of glass with an inner layer of plastic similar to that used in automobile safety glass).

The extra thick plastic of the inboard laminated glass extends beyond the edges of the glass about one inch and has imbedded in it a metal collar for additional strength. This Metl-flex extension, engineered during the war, is then encased in rubber for a flexible cushion against torque stress. Then the over-all assembly is securely fastened to the car frame.

Glare is substantially reduced by the combination of the heat-absorbing plate glass of the outboard sheet, which is somewhat darker than regular plate glass, and by the special glare-reducing, extra-tough plastic of the laminated safety glass.

The outboard glass contains a special ingredient which absorbs a considerable percentage of the infra-red or heat-carrying rays of the sun, re-radiating the heat of the sun to the outside of the car, thus assisting the insulating qualities of the glass in maintaining comfortable temperatures within the car.

By heat-tempering the outside sheet of glass, it becomes three to five times stronger than regular plate glass This, coupled with the inner laminated safety plate glass, is given additional strength by the Metl-flex sashing which tends to "give" but not shear at the fastenings under impact. Under severe tests, the special railroad Thermopane units have resisted hurled objects even more effectively than steel plates used in the train roofs.

Thermopane utilized in windows of the main body of the cars is virtually the same as that used in the Astra Domes, but the units are mounted in a newly designed rubber gasket instead of the sash common to most train windows. By this method, it was possible to provide a greater area of glass, thereby affording passengers a considerably increased range of vision.

As installed in the Train of Tomorrow, the Thermopane units eliminate fogginess, condensation and drafts.

4. Engine, Generator and Motor Design: Special design problems had to be solved by the train's engineers to provide all of the Diesel engines, motors and generators, which are basic components of the independent power source engineered especially for the train.

Minor changes in the standard lubricating system of the diesel engines were required to insure proper oiling of all moving parts when roadbed clearance dictated angular mounting of the engines beneath the cars.

The engines are water-cooled by a radiator mounted outside the engine enclosure, equipped with an electrically operated fan powered by a Delco motor. Mufflers are also mounted externally. Up to 500 cubic feet of air per minute, taken from the interior of the car at a temperature of 80 degrees F., is drawn through the generators and discharged into the engine compartments. This air improves engine operation by providing optimum environment and warm air for the engine intake. A small fan on the crankshaft ventilates the engine enclosure. These precautions for cooling and heating assure maximum performance in sub-zero winter or 130 degree summer heat.

Automatic overspeed, low oil pressure, and high temperature safety devices have been provided. Manual stopping and starting controls are installed in both engine compartment and interior of the car. Hundred-gallon fuel tanks under the car floors feed the Diesels and permit a transcontinental run without refueling.

5. Axles, truck frames and other safety features: Axles, truck frames, swing hangers, coil springs and shock absorbers in the Train of Tomorrow include some revolutionary advances that contribute to both comfort and safety. The train incorporates two distinctive improvements:

a. Outside swing hangers;

b. Roller bearing journal boxes of advanced design which include an arrangement permitting lateral movement of axles within limits established by thrust blocks mounted on synthetic rubber cushions.

Outside Swing Hangers

In the standard suspension of railroad cars, swing hangers are mounted inside the truck frame, 56 inches apart at the lower ends. In the new design, they are mounted outside, 96 inches apart. The difference is similar to the difference in your sure-footedness when you stand with feet together and with feet wide apart.

Moreover, the hangers taper toward the top, causing an automatic "banking" on curves, proportioned to the speed of the train and the degree of the curve. The centrifugal force that formerly was upsetting to passengers is thus harnessed to increase stability.

Not only does this design cut sidesway, it materially increases the ability of the truck to dampen out shocks from imperfect track alignment, rough roadbed, sharp curves and similar conditions. But sidesway is the most important factor affected. In a test, an old-style car swayed 28 inches at roof level (14 inches to either extreme from the mid-point); the new car swayed less than six inches (3 inches to either extreme.) The development is particularly important for cars with Astra Domes which give added weight at a higher level. These hangers have been used with signal success on General Motors Diesel locomotives for a decade.

They have also been installed by some railroads to overcome unusual problems. One road utilized the hangers to reduce sidesway in narrow tunnels where previously cars had actually scraped against tunnel walls and cars going in the opposite direction.

Roller Bearing Journal Boxes

The fight against friction is a ceaseless struggle in railroading.

In the Train of Tomorow, journal boxes are standard on the trucks of the locomotive and all the cars—and the installation is of newest design.

The new bearings require oiling only every 20,000 miles, and will

operate satisfactorily at speeds far in excess of any common on existing railroads. Hot boxes are virtually unknown, due to the high precision manufacture of these components from special alloy steel and bronze.

Lateral Axle Movement Snubbed

Snubbers on automobiles are familiar to most people. They permit vertical movement when wheels strike bumps, but apply a braking action that cushions the shock.

A snubbing influence, similar to that exerted by automobile snubbers, is exerted on the sideward motion of the axles of trucks on cars of the train through a new development. The controlled lateral movement of the axles is cushioned on a synthetic rubber member which is interposed between the axle thrust block, which engages the end of the axle intermittently, and the front or outside cover of the journal box.

Passage through a track switch offers an excellent opportunity for this lateral-snubbing to show its advantages. The former, jerky thrusting from side to side is gentled down to a mild cradle-sway.

Journal boxes equipped with this snubbing action have proved their worth in hundreds of thousands of miles of service on locomotives, but are used for the first time on railroad passenger cars on the Train of Tomorrow.

Other Effects

The brake system of the Train of Tomorrow includes all electric features and wheel slide control devices that smooth stops.

Coil springs and four Delco direct-acting shock absorbers on each car multiply the comfort and safety factors built up in the new truck structures. An extra shock absorber installation on the final car prevents "whip-cracking" action.

Aside from increased comfort and safety, the new equipment contributes economy of operation through greater wheel tread and flange life derived from reduced stresses.

These types of problems are but a few of the many that were solved for the Train of Tomorrow. There will be more like them—many more—for professional engineers to solve as railroads start ordering cars for the new luxury trains on a large scale.

Consequently, railroad passenger car building offers a broader field of opportunity to many types of engineers than it ever has in the past. But if you are interested in entering this broadened field, do not apply to General Motors. The designers of the Train of Tomorrow have no intention of entering the passenger car building field.

The improvements originally were suggested, in drawing and scale model form, by General Motors, the locomotive builder, as a contribution to the general movement within the railroad and railway supply industries to make rail travel more attractive. General Motors had the innovations built into the Train of Tomorrow in response to the suggestion from many of its locomotive customers that the advances would be hastened toward general adoption if prototypes were put on the rails for test under actual service conditions.

New Factors Considered In Reexamining Compton Report

(*Continued from Page* 14)

widespread interest in engineering continue, the number of such transfer students will increase materially.

Transfer Students

These transfer students will still further accentuate the grave problems already facing the engineering colleges in their preparations for providing specialized instruction in the various branches of engineering to the thousands of upper class students coming out of the tremendous lower classes now on their campuses. They will also produce more graduates than are indicated in Table V.

According to recent figures released by the Veteran's Administration, 4.8 million veterans had applied for educational benefits under Public Laws 16 and 346 up to the end of October, 1946, and applications were being received at the rate of 10 thousand per day. Four and three-tenths million had been approved for training under Public Law 346, of whom 1.8 million were actually in training of one sort or another and 0.2 million had completed the period of training allowed them under the law. Of those in training 1.1 million were enrolled in colleges and universities.

It is estimated that about 74 percent of the veterans who receive certificates of eligibility for training definitely plan to use them, that an additional 15 percent may perhaps use them, and that the remaining 11 percent probably will not use them. It is not known how many veterans will ultimately apply, but if we assume that only 6 million apply, and that only 70 percent of these will actually use their certificates, it will mean that 4.2 million veterans will be receiving training under the G. I. Bill during the nine years subsequent to the formal ending of hostilities. If present ratios hold, 2.5 million of these veterans will attend college, of whom 270 thousand will enroll in engineering.

Enrollment Denied

No accurate figures are available as to the number of students whose applications for college enrollment were denied this fall because of lack of space. A recent survey of opinion of responsible educators, conducted by the U. S. Office of Education, shows that about 80 percent of those responding were of the opinion that the number of academically qualified veterans unable to secure admission to some college this fall was either none or few enough not to constitute a serious problem, while about 20 percent felt that the number is sufficient to be of serious concern. About the same ratios hold with respect to non-veteran high school graduates. Three-fourths of the respondents believed that the steps now being taken within the state are adequate to care for all qualified applicants seeking college admission this year.

The President's Commission on Higher Education has indicated its belief that the colleges are now handling only about half of those qualified to attend and asked itself what steps need to be taken to meet the problems implied.

How many students failed to gain admission to the college of their choice is another matter concerning which no specific information is available, but it is common knowledge that the number enrolled in temporary colleges, and the number

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of regular college freshmen "farmed out" by universities and colleges is large, and that in another year or two many thousands of these students will be seeking transfers to specialized divisions of colleges and universities. Among these will be large numbers of students wishing to specialize in engineering or science.

One indicator of the interest in technical and scientific education among students in non-engineering colleges is found in the calls for help in the acquisition of scientific and engineering equipment which have come to the Office of Education in Justifications of Need submitted to the field offices of the Veterans Educational Facilities Program. Here again no exact figures are available, but a hasty examination indicates that a majority of the institutions are anticipating, or already have, large increases in the number of students enrolled in courses requiring such equipment.

Providing for Transfers

It seems evident that the engineering schools will be faced next year and the year after with the problem of attempting to provide for many thousands of transfer students at the sophomore and junior levels. We always have had such transfer students, but their number seems destined to increase very largely during the next few years.

5. In the estimate of the demand for engineers in this country there are also many chances for errors, some of which are pointed out in the Compton Report. Dr. Trytten, the Director of the Office of Scientific Personnel of the National Research Council, and I were responsible for the preparation of this part of the Compton Report. I have conferred with him and also with our consultant in the Bureau of Labor Statistics. The latter states that according to their statistics the country has nearly reached the theoretical "full employment" discussed in the Compton Report (disregarding current strikes). He says further that the separate rate is about as high now as it was during the war, indicating that many people are transferring from one job to another. He questions where there is any large unfilled need for engineers at the present time in industry. He points out that a large number of people every year enter industry in engineering positions without engineering degrees, and that unless we assume that these people are to be replaced later by college graduates we must consider them as engineers. The Bureau of Labor Statistics is still engaged in their study of the need for engineers in industry, and hopes to publish it within the next few months. Thus far no figures are available from their study, but the general opinion is that their study will show a smaller need for engineers than does the Compton Report.

However, Dr. Trytten and I still feel that our estimate in the Compton Report is probably conservative, for the reasons stated in the report. We still believe that the ratios of engineers to total employment will increase as industry becomes more and more complex and turns more and more to engineering control and to engineering and scientific research. Certainly our country is not getting the production which is needed for the good of our country and of the world. If all of the available labor force is employed the only way to increase total production is to increase the productivity of the individual laborer. This is of course quite largely an engineering task.

In our original study we estimated that after the attainment of "full employment" in 1950 the number of engineers needed merely to keep up with the growth in population and to provide for replacements in the profession would be from 10 to 12 thousand per year, or approximately the number of engineers who were being graduated from engineering colleges before the war. We mentioned the sharp increase in emphasis on research and development evidenced by the returns to the industrial questionnaire. This also is evidenced by the competition for top-flight scientists and engineers by government agencies, such as the Army, the Navy, the Joint Army-Navy Research Board, the Public Health Service, the National Bureau of Standards, the Veterans' Administration, and others.

This sharp increase in emphasis on research and development is an extremely significant factor in any determination of future needs for engineers, since it obviously points to greatly increased needs for thoroughly trained engineers and scientists. Some production jobs may perhaps be filled by mediocre engineering graduates or by competent graduates of technical institutes, but the research and development positions certainly will require a higher type of engineer and scientist.

All of these general trends lead us to believe that the Compton committee's estimates of demand for engineers in this country are more likely to be too small than too large.

Problems for Engineering Colleges

It is my opinion that the foregoing estimate of the need for engineers in this country may be a little too small, but that the estimate of supply is likely to be too small by a higher percentage.

No estimate was made by the Compton committee of the demands of the devastated countries for American engineers. This demand may be heavy for a short time, but should decrease rapidly as the colleges and universities in these countries are restored to usefulness. The young men of these countries are undoubtedly seeking educational opportunities denied them during the war just as eagerly as are the young men of our own country, and it seems safe to assume that the number seeking careers in engineering and science is at least comparable to that in the United States.

In any event, it is evident that there are serious problems facing the engineering colleges *now*. I should like to outline very briefly a few of these problems as I see them, without attempting to solve them. I assume that many other problems will occur to you engineering educators who are "on the firing line." I am quite certain that the solutions must be worked out by you and your colleagues in the colleges. I believe that what you and your colleagues do about these problems may have a profound effect, not merely on engineering education, but upon all education, and upon the entire national economy.

It seems obvious to me that this country is now starting on a program of broadening the base of higher education in much the same way the base of secondary education was broadened after World War I. A much larger percentage of our youth will attend college in the future than before the war. We have obligated ourselves as a nation to give each veteran the opportunity to secure an education. We owe it to him and to ourselves to see that he gets the kind of education he is qualified to take, and from which he can expect to emerge as a more useful citizen. We need to take account of the increased maturity of the veterans, of the fact that they are interested in public affairs and in world affairs, and of

the fact that they must first of all be good citizens.

The prime function of the engineering college is to prepare men and women to understand and to aid in the technical and scientific advancement which is developing with such rapidity as to constitute a scientific and ideological revolution. For these people mere technical and scientific competence will not suffice. They must also have a vital awareness of the social, political, and economic implications of scientific and technical developments, and the ability to do something about them. We must develop a program which can produce men and women who can intelligently use the scientific method in attacking social and political problems, and can appreciate and take into account the social and political aspects of engineering and scientific problems, in short, men and women who can be "engineering statesmen."

Basis for Selection

What should be the basis for selection of students in such a program? Should the engineering colleges admit all who can meet present requirements, or should they screen their candidates more carefully for indicated ability and aptitude to profit from an engineering education? Should admission be based on paper records of credits or on mastery of necessary foundation subjects? Many believe that a well organized testing program, such as the engineering inventory, is a better indicator of success in college than a high school record several years old.

What kind of guidance should be given veterans and others as to their future occupations, and by whom? Surely a grave responsibility rests on the engineering colleges, in view of the tremendous number of present and prospective students, both qualified and unqualified, seeking to be engineers and because of the great need of industry for really competent engineers and scientists.

The Compton Report stated that there is a need for from three to five times as many technical institute graduates as graduate engineers and indicated a short term need for about 75 thousand such people per year. The committee pointed out that "the ability of technical institutes to meet this demand is problematical." This shortage of technical institute graduates, coupled with the indicated surplus of graduate engineers, may mean that many graduate engineers will find themselves assigned to work which could be done satisfactorily by technical institute graduates. Does this call for a revision of engineering curricula and of the general administration of engineering colleges? Is it possible that society would be better served if provision were made for a certificate of proficiency at the end of two years for those who have not demonstrated their ability and their aptitude for professional engineering work? At least one engineering college is planning to give an achievement test at the end of the sophomore year to decide which students may proceed toward degrees. Certificates will be given to others meeting certain standards in the test.

If such a program becomes general, what changes in courses and teaching methods are indicated for the work of the first two years, and what for the work of the last two years? Should the work of the first two years more nearly approach the Technical Institute type of program? Should the work of the last two (or three) years attempt to *train* for the rank and file of engineering jobs, or to *educate* for leadership in industry, teaching, and research? Should the urge of the veterans for *speed* mean they should be given ESMWT training, or should some of the techniques developed in ESMWT courses be used to revitalize and intensify engineering education?

Does the pronounced shift toward research in government and industry mean that the engineering colleges should increase their efforts to persuade their best students to continue with graduate work, for their own good and for the good of the country?

What kind of teachers do the engineering colleges need and how can they be recruited? Can programs be developed to train engineers to teach? Can industry and education work out some sort of a cooperative system for teachers as they have done so successfully for students?

What sort of relations should there be between higher education and the Federal Government? Should there be a program of Federal aid to education? If so, should it be extended to individual students or to institutions, or both? Should it be extended only during the present emergency, or permanently? If to institutions, should it be extended only to tax-supported institutions or should the privately supported tax-exempt institutions share in it? The Federal Government is now aiding individuals through the G. I. Bill and Public Law 16. Legislation has been proposed setting up a system of Federal scholarships. Institutions, both public and private, are being aided through the veterans housing program and the Veterans Educational Facilities Program in the acquisition of equipment and temporary buildings. A bill to establish a program of Federal aid in the erection of permanent buildings was debated in the last session of Congress. How far should efforts to meet an emergency be allowed to color permanent policies? In this country education has traditionally been considered a function of the States. Should the base be now broadened by making it at least partly a function of the Federal Government? If so, should Federal funds be used to partially equalize educational opportunities in the various states?

Change Curricula

We engineering educators have long maintained that engineering education is good general education and that it forms a good foundation for almost any activity in modern life. Nevertheless we have organized our curricula with the primary objective of preparing students for engineering work. Should we now modify our present curricula, or perhaps set up new curricula, in order to give students a good general fundamental training in the basic physical sciences and a general understanding of engineering and scientific procedures? Such curricula would not be designed to prepare students to be engineers, but simply to prepare them for more intelligent citizenship in this age of science and technology. I have long maintained that one of the greatest benefits an individual can derive from an engineering or scientific education is the development within himself of the scientific method of thought—the method of basing his conclusions on facts rather than on prejudices—of attempting to find out what is true and to live in accordance with the facts. I believe that this is the reason for the success graduate engineers have attained in nearly all walks of life, and I personally believe that the greatest need of the world today is for more men and women who have this scientific attitude of mind, and who will apply it to the world's problems, whether they be designing a bridge or a peace treaty, operating a railroad or a nation. Perhaps here lies the greatest opportunity for service by our engineering colleges, and their greatest challenge.

Methods of Achieving Professional Recognition

(*Continued from Page* 10)

Two Major Councils

The largest and most important engineering societies, while maintaining their own individual committees on ethics, professional conduct and economic problems, have joined forces for the study of professional problems in two major Councils, the Engineers' Council for Professional Development, and Engineers' Joint Council.

Fortunately, in this group, I do not have to explain what the E.C.P.D. is or what its objectives are. In other groups I have not been let off so easily. In fact, many lifelong members of the Founder Societies have yet to learn of the existence of E.C.P.D. or E.J.C.

You are also thoroughly familiar with the E.J.C. and its organization. Some of its objectives appear to compete with or overlap those of E.C.P.D., but no doubt there is a coordinating genius somewhere.

Both of these joint efforts are noble attempts to supply a great deficiency. If I am not over hopeful of their ultimate results, it is because by service on sub-committees of both, I am painfully aware of the general ineptitude of the setup. Nothing would seem more fundamental to professional unity than a common Code of Ethics, yet the Cannons proposed by E.C.P.D. five years ago are still unratified. The sub-committee has received sufficient encouragement this year so that we are willing to try again, and we are not without hope of ultimate success, but this protracted delay in arriving at such a fundamental objective illustrates one major defect in a league or coalition of sovereign societies.

Remote from Individual

On the local level, we have various attempts to combine our diverse technical societies for professional objectives. An outstanding example is the Engineering Societies of New England, Inc. Like most local coalitions, it is a heterogeneous group with hundreds of members who are not, and never will be, professional engineers. Nevertheless, the E.S.N.E. is closer to the individual member in Boston, and he feels that he gets more service from it along professional as distinct from technical lines than from the more ambitious Councils on the national level.

There is one society among the 30 or 40 or 71, depending on how inclusive you make the term, and only one, whose membership is limited to professional engineers. This is the National Society of Professional Engineers. It is a society organized very frankly in imitation of the American Medical Association, minus the Scientific Assembly. Its objectives are solely professional, leaving technical and scientific pursuits to the other 70 societies more or less, which are organized for those purposes. It is a relatively small group, at the moment, but is growing rapidly. It had 13,000 members at the end of March and is expected to have 25,000 before the end of the year.

NSPE Organization

There are now 22 component state societies, the larger ones divided into local chapters. Other state components are in process of organization. These state societies may have "engineers in training" as junior members and some have student branches, but only registered professional engineers are members of the national society.

The National Society of Professional Engineers has all the potentialities of the American Medical Association. It is organized along the same lines, for the same objectives, and with the same simple but definite rule of eligibility. Its potentialities can be realized, however, only when it has a representative membership, that is, when it includes the great majority of professional engineers, and substantially all of the acknowledged leaders of profession, many of whom are not even eligible because of their scorn of legal registration. Educators are conspicuously absent from the membership rolls, in many states. They do not have to be registered and so they neglect this obvious opportunity to furnish inspiration and leadership to the young men who look to them for both.

Young Men Registering

The young men, however, are getting registered. They are more acutely aware of the problems besetting the future of our profession than many of their elders. The leaders of the future then will at least be eligible to join a society of this type. But events will not wait for these boys to mature. We must have immediate and constructive leadership from our present leaders. The young men are looking for that; let us not disappoint them. Let every one of us, from the college freshmen to the presidents of the Founder Societies, acquire a firm grasp of the meaning of a profession and its obligations. Let us develop a group consciousness, recognizing that our group includes all professional engineers and all candidates for that vocation. Let us accept in spirit as well as in law, the legal status which E.C.P.D.'s Committee has correctly named an indispensable attribute of a profession, and let us organize intelligently and effectively for these objectives. When these things are done, we shall achieve professional recognition.

Attributes of a Profession and Its Practitioners

Of a Profession:

1. It must satisfy an indispensable and beneficial social need.
2. Its work must require the exercise of discretion and judgment and not be subject to standardization.
3. It is a type of activity conducted upon a high intellectual plane.
   a) Its knowledge and skills are not common possessions of the general public; they are the results of tested research and experience and are acquired through a special discipline of education and practice.
   b) Engineering requires a body of distinctive knowledge (science) and art (skill).
4. It must have group consciousness for the promotion of technical knowledge and professional ideals, and for rendering social services.
5. It should have legal status and must require well-formulated standards of admission.

Of Professional Practitioners:

1. They must have a service motive, sharing their advances in knowledge, guarding their professional integrity and ideals, and tendering gratuitous public service in addition to that engaged by clients.
2. They must recognize their obligations to society and to other practitioners by living up to established and accepted codes of conduct.
3. They must assume relations of confidence and accept individual responsibility.
4. They should be members of professional groups and they should carry their part of the responsibility of advancing professional knowledge, ideals, and practice.

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National and State Society News

NEWS FROM THE WASHINGTON OFFICE

With this issue of THE AMERICAN ENGINEER the second major step in the improvement of our magazine has been accomplished. I am sure it will be apparent to all as they receive the magazine that we have now adopted letterpress method of printing on better stock paper thus permitting considerable improvement in the appearance of the magazine. These negotiations together with development of a new editorial policy with the advent of our own editor have occupied some time of the Washington Staff.

The editor has been busy acquainting himself with the policy of NSPE and conferences with both the Executive Director and with members of the publications Committee have led to the first steps in the development of editorial and printing policy which will assure the membership of a continually improved AMERICAN ENGINEER.

Washington Meetings

Considerable interest was shown at the State Secretaries' Conference and the Summer Meeting of the Board of Directors at the Statler Hotel in Washington, D. C. The Washington Office was busy in making the necessary preparations for these two meetings and Secretaries of all Member State Societies, with the exception of two were in attendance. Further details regarding these meetings, the discussions involved and the decisions reached will be reported in detail in the next issue of the magazine.

On June 14th the Special Committee under the Chairmanship of Mr. William Ryan of Massachusetts, appointed to consider the problems of industrial groups, met in New York for the preparation of their report to the Board. At this time representatives of several of these groups met with the Committee to discuss ways and means for the Society to be of greater service to this segment of the profession. The Executive Director had the pleasure of participating in these discussions and the report of the Committee will be of interest to all members.

Education Speaker

Mr. Walter H. Wheeler, Chairman of the Society's Committee on Education, addressed the American Society for Engineering Education on the subject "Training of a Professional Engineer" at the Annual Meeting of that Society on June 18th in Minneapolis. The Educational Committee is continuing to study the reaction of the Deans of engineering schools of the country on recommendations of the Society regarding the future training of engineers.

Mr. M. W. Cameron, Chairman of the Society's Committee on Public Relations spent several hours in the Washington Office discussing the program of this Committee and reviewing correspondence on this subject forwarded to the Society by interested members. A comprehensive program of Public Relations is planned in the near future, a report of which will be forthcoming shortly.

Mr. Fullers report on the activities of the Legislative Committee this month indicates the degree of success with which the engineering profession met in securing remedial legislation for various abuses of labor activities through the passage of the Taft-Hartley Labor Law.

Membership Increasing

Membership of the Society continues to show an encouraging increase, the rate of increase holding steady over the past 18 months. This is of course encouraging but it is hoped that with the resumption of activity in the Fall, an even greater increase in membership will be shown.

The Washington office has conseveral State Societies who are tinued to keep close contact with actively investigating the desirability of affiliation with NSPE.

Vice President Van Praag visited the Utah Society of Professional Engineers and addressed their Annual Banquet on July 2nd. Vice President Stanford is actively working with the professional engineers of South Carolina and Florida toward the formation and affiliation of State Societies of Professional Engineers.

District of Columbia

The District of Columbia Society recently held a most successful annual dinner meeting in Washington's Continental Hotel. The following new officers were elected for the coming year: Herbert Manuccia, president; C. Warren Bogan, first vice-president; Melville L. Brown, second vice-president; Charles H. Jennings, secretary-treasurer; Edwin M. Woods, director; and Frederick W. L. Hill, alternate director. These new officers have already held their first meeting to plan for the coming year, which it is expected will see enactment of a registration law for the District.

Illinois

Milton T. Holloway, new field secretary of the Illinois Society has already visited several chapters and groups which may form new chapters.

Major selling point in the new chapter program, according to reports from Illinois, is the feeling of a need for national organization of the type provided by NSPE.

In carrying on his organizational program, Mr. Holloway has been using a pamphlet entitled, "Why should I belong to the National Society of Professional Engineers?" Mr. Holloway prepared the pamphlet himself.

Coming Events To Remember

National Meetings

December 4, 5 and 6. NSPE Annual Convention, Statler Hotel, Buffalo, N. Y.

Reports on the growth of national members in Illinois are encouraging. Furthermore, the State Board of Directors has ruled that after July 1, 1947, any new member that has the necessary qualifications for national membership will be accepted only as such a member.

Massachusetts

Massachusetts engineers are becoming registration conscious, according to reports received from the Metropolitan (Boston) chapter. This tendency is indicated by an increasing number of applications for registration as well as by attendance at both state and chapter meetings.

During the past year six meetings have been held in Boston—three by the State Society and three by the Metropolitan chapter. The Boston group reports an average attendance in excess of one-third of total membership.

Holcombe J. Brown, consulting engineer and secretary of the Massachusetts State Board of Registration, addressed the annual meeting of the Metropolitan Society. Mr. Brown said that the Board has received some 5,800 applications in the past five years, including about 2,300 during 1946. He also said that 2,400 applications were received during the first quarter of this year, indicating a substantial increase in state registration.

Albert Haertlein, professor of civil engineering at Harvard and Chairman of the Board of Registration, was a guest at the meeting and participated in the discussion.

Minnesota

Dr. Charles A. Mann, head of the Department of Chemical Engineering at the University of Minnesota and a staunch NSPE member, has been elected president of the Engineers' Club of Minneapolis.

* * *

District 2 held a recent meeting in Mankato at which there was a discussion of professional fees for expert testimony at court trials. Richard Price, Secretary of the Minnesota State group, also spoke, emphasizing two points: (1) that MAPE members should abide by their own Minimum Fee and Salary Schedule and protect it from encroachment by themselves as well as by others and (2) that the engineer should maintain his proper relationship to his community and his government.

* * *

Minnesota's newly-revised Schedule of Minimum Fees and Salaries has been issued and copies have been mailed to all members of the State Association.

New York

The Board of Directors of the Erie County chapter has received a communication from the New York State Attorney General commenting on the problem of telephone directory listings of "engineers." Sum and substance of the ruling is: Anyone may use the term "engineer" as a title, but only those having a license may use the title, "Professional Engineer."

The Board also received a progress report on the National Convention which is to be held in Buffalo, December 4, 5, and 6, 1947. Much work has already been done in preparation for this event—but plants are not yet complete.

* * *

The Bronx County chapter held its annual meeting on June 5 for the election of officers, installation of officers, annual reports of committees and ending with a social hour.

* * *

Henry Spoull, chairman of the Erie County chapter, reports that this group has met its 1946-47 goal of 40 new members and 4 reinstatements.

Mr. Sproul has also been put in charge of the 1947-48 membership goal of 60 for the chapter,

* * *

The Westchester County chapter held a meeting June 24, in Pleasantville. A directors meeting was held at 6:30, with the General meeting following. Two motion pictures were shown, dealing with: (1) floating drydocks and (2) activities of the Seabees. This was the chapter's final meeting of the season.

Ohio

The Cincinnati Chapter held its special annual meeting at the Cincinnati Yacht Club to announce the results of its election and install the new officers, who are: James S. Lineback, president; Frank H. Woods, first vice-president; Leonard A. Bauer, second vice-president; Harry J. Long, treasurer; and Alfred Le Feber, secretary.

* * *

The Maumee Valley chapter held its June meeting in Lima where Allen Owen, member of the law firm of Owen and Owen, Toledo, spoke on the subject, "Patents." Mr. Owen's law firm specializes in patents and trade marks, and Mr. Owen himself holds a degree in electrical engineering as well as in law.

* * *

The Marion chapter held a meeting Monday evening, June 12. Dinner was followed by movies and a talk by Mr. Davies, consulting engineer of the Lincoln Electric Company, on the "Use of Jigs and Fixtures in Welding" and a "General Talk on Arc Welding Covering Electrodes, Power Supply, and Uses of Welding."

The meeting also saw a movie on new structural design.

Texas

The Nueces Ladies Auxiliary held its first Board meeting on Thursday, May 20. The president appointed the following committee chairwomen: Hospitality, Mrs. Nat W. Hardy; Membership, Mrs. Joe E. Woods; Program, Mrs. J. C. Harris; Public Relations, Mrs. T. O. Foster, Jr.

Mrs. W. A. Raatz was elected Parliamentarian by the Board.

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Send Inquiries Direct to American Engineer, 1359 Connecticut Ave., Washington, D. C.

NEW VOLTAGE REGULATOR

A new Instantaneous Electronic Voltage Regulator has just been marketed. It is a completely electronic device with no moving parts, and provides the instantaneous correction of line voltage fluctuations with negligible waveform distortion so necessary in all laboratory and industrial voltage regulation applications.

Extensive tests under all conditions of operation have proved the superiority of performance offered by this new voltage regulator. The output voltage is rigidly held to within ± 0.1 volts of any nominal value in the settable output range between 110 to 120 volts for an input line voltage change from 135 to 95 volts. Although the time for recovery varies, depending upon line voltage, load current, load power factor and other conditions, it usually is in the order of 3 to 6 cycles. Performance of the new regulator is not affected by any load change from zero to full rating of the unit. It is independent of any load power factor change from a lagging .5 to a leading .9.

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For further information address American Engineer, reference No. 700.

NEW ENGINEERING DATA BOOK

A fully illustrated 12-page bulletin on voltage control has just been released. This new bulletin features the latest developments in variable transformers and automatic voltage regulators. All the information on voltage control equipment necessary to management, designers, and engineers has been included in concise, easily read form. The bulletin is complete with ratings, detail drawings, photographs, and performance and engineering data. Copies of the bulletin are available for immediate release.

For further information address American Engineer, reference No. 701.

STEAM SEPARATION BULLETIN

A new bulletin, "Steam Separation," describing equipment for steam separation in boiler drums, steam scrubbers and steam separators has just been released. Operation of the equipment is shown, together wi illustrations of applications in seve types of boiler units.

For further information address Am ican Engineer, reference No. 702.

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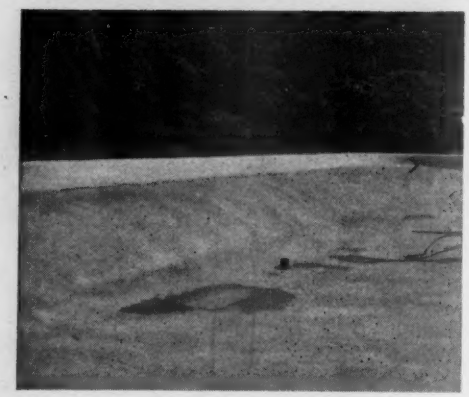

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